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In Cooperation with the Office of Vegetable and Forage Diseases,
Bureau of Plant Industry, U. S. Department of Agriculture.

DISEASES OF LETTUCE, ROMAINE, ESCAROLE, AND ENDIVE

By
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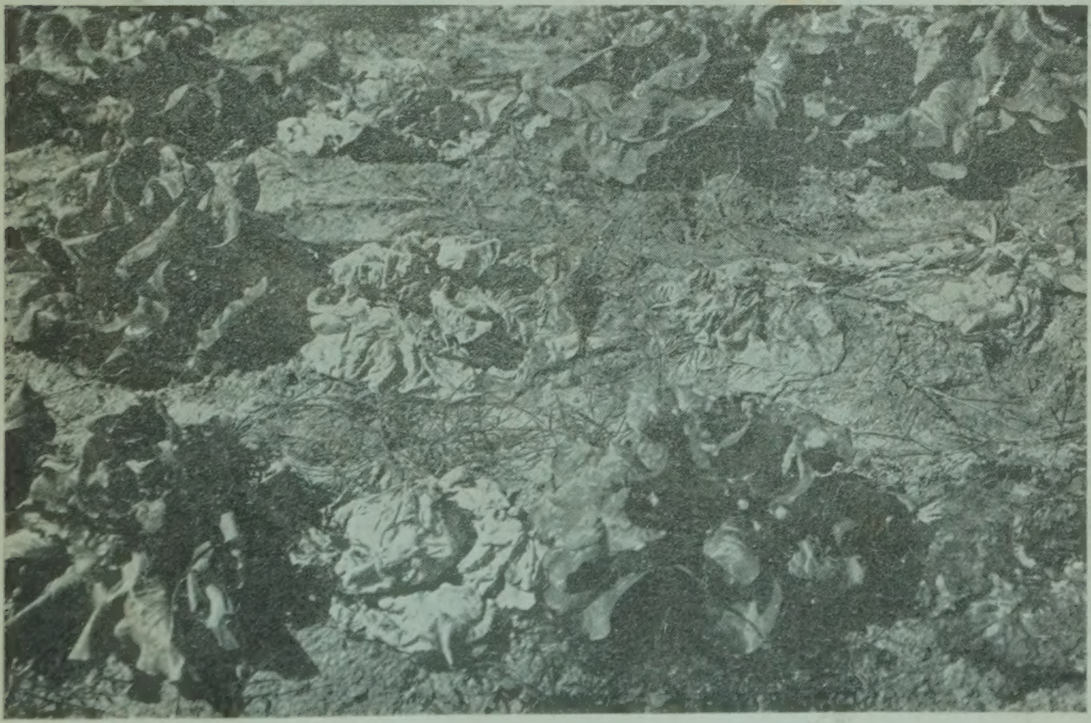

Fig. 123.—Drop disease in the lettuce field.

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DISEASES OF LETTUCE, ROMAINE, ESCAROLE, AND ENDIVE

By G. F. Weber and A. C. Foster*

INTRODUCTION

The production of lettuce in Florida has been decreasing during the past five years. In 1922 there was a production of over 3,000 cars, and in 1927 the production was less than 1,000 cars. This decrease in production may be attributed primarily to two causes; the heavy losses sustained by growers due to the prevalence of diseases in the field and decay in transit, and a decline in the market price for the Big Boston type of lettuce.

The market price is regulated principally by the supply of lettuce on the markets and the condition of that commodity at the time it is purchased by the retail trade. Because of the succulent tender condition of lettuce at all times it is more subject to decay than almost any other vegetable, and its freedom from decay at arrival on the markets is determined mainly by the way it is handled at time of harvest, the way it is packed in crates or hampers and the methods of loading in refrigerator cars. Proper refrigeration and precooling of the car is almost essential to insure good condition on arrival.

It is the purpose of this bulletin to describe the diseases of lettuce and related crops and give in so far as they are available control measures. Unfortunately, many of the diseases of these plants cannot be satisfactorily controlled or prevented in the field, but by careful handling of the crop at time of harvest and by following the advice given as to handling, crating and precooling, it is thought that the suggestions offered will in many cases greatly reduce the losses incurred by the growers.

The scope of the bulletin is limited to the diseases found in the field and those which subsequently in transit cause decay of lettuce, *Lactuca sativa* var. *capitita* and the closely related plants, Romaine, *Lactuca sativa romaina;* Endive, *Cichorium endiva;* and Escarole, *Cichorium intybus*. These plants are grown during the same season and in the same localities in the state. Lettuce is far more important commercially than the other three combined. This crop is followed successively in importance by romaine, escarole and endive. In dealing with the specific diseases the information in each case applies to lettuce and also is applicable to the others. Where the symptoms of the diseases are different, or where the disease is more important on one of the crops other than lettuce, definite notations are made.

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These diseases have been observed in the fields over the state for the past five years by the writers and during that time considerable experimental data were accumulated. Information published herewith is derived from these observations and accumulated data. Occasional references are made to the existing literature but in these cases it is usually of historical importance only.

DROP

Drop is caused by soil inhabiting fungus, *Sclerotinia sclerotiorum* (Lib.) Mass., and *Sclerotinia minor* Jagger. The disease is commonly destructive in all portions of the United States where lettuce, romaine, endive or escarole is grown, being most destructive on lettuce. Florida is no exception. This disease is state-wide in occurrence, and one can almost use the term omnipresent in describing its distribution on plants. It is probably as widespread in its host range as any other common disease, having been reported on more than 50 different hosts in Florida. It was first reported from this state about 20 years ago and since that time has been an important disease.

Virgin soil usually is quite free from this disease but with constant cropping the soil becomes infested with the fungus, spores and sclerotia which act as sources for the development of the fungus. It has been found on all types of soil in the state but is more prevalent on the muck soils and more common during the cooler growing season of late fall, winter, and early spring than during the warmer portions of the year. Its prevalence during this period of the year is partly because the crops are grown at this time in Florida, and partly because the fungus grows best at a relatively low temperature (60-70°F.), remaining dormant during the summer months until after the first cool spell, which usually comes during November. At this time the sclerotia or resting bodies germinate, producing many small spores or seed-like bodies which are disseminated through the air and by dew, rain and running waters. It is neccessary also that adequate moisture be present, otherwise the fungus does not develop as readily, nor is it as severe.

Plants are attacked during all stages of their development from the seedbed to market. It is of considerable importance as a damping-off fungus in the seedbeds, in attacking the plants in the field from transplanting time until harvest (see figure 123), and in transit, where it causes considerable loss. The severity of this disease in the field is usually the result of constant growing on the land of the same crops or of other susceptible crops. Unfortunately, practically all of the common winter-grown crops of Florida are attacked, including lettuce, celery, tomatoes, beans, potatoes, cabbage, eggplants and others.

Losses in the field often include the entire crop. Transit losses are prevalent also, especially where the grower fails to recognize the importance of carefully trimming off all diseased leaves. For further information on the handling and precooling of Florida lettuce and celery, see publication by Ramsey and Markell.[1]

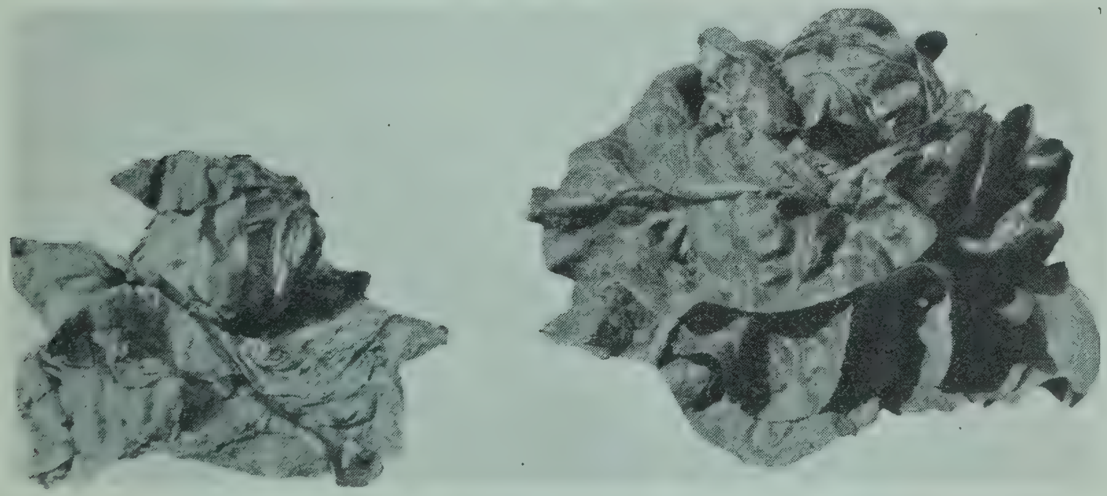

Fig. 124.—Left: Lettuce plant showing the drop disease in most characteristic form; right: healthy plant.

The disease is found in the seedbeds from early fall to early spring. It is most favored in its development by the low temperatures of the cooler parts of the year, although the growing plants show symptoms of the presence of this disease during dry periods. The fungus is soil inhabiting and remains dormant during unfavorable seasons in the black, irregular sclerotia. These sclerotia produce fruiting bodies which look like miniature mushrooms, known as apothecia, which in turn produce spores which are microscopical and are scattered by wind and rain. The production of apothecia usually begins in the fall and continues during late winter. They are usually found in refuse piles in the woods where the previous season's debris from the field has been dumped, and also in the field itself, especially when a spring crop of lettuce or celery has been grown in this soil.

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[1] Ramsey, H. J., and Markell, E. L., The Handling and Precooling of Florida Lettuce and Celery, Bull. 601. United States Department of Agriculture.

SYMPTOMS

The first symptom on a plant that is attacked by the drop fungus is a general lack of turgidity. The older leaves appear to be limp and wilted, gradually the wilting increases, involving more of the leaves toward the heart of the plant until all of the loose leaves not in the head are prostrate on the ground. The heart leaves sink into a soft mass. This condition is rapidly followed by a drying and browning of the infected tissues.

Upon removing from the soil a plant which shows the first wilting syptoms one can usually find a more or less cottony development of the fungus itself around the main stem of the plant in the cavities between the petioles of the leaves and the surface of the soil. The main stem is completely girdled and rotted through and in most instances will break off close to the soil line when the head is pulled up.

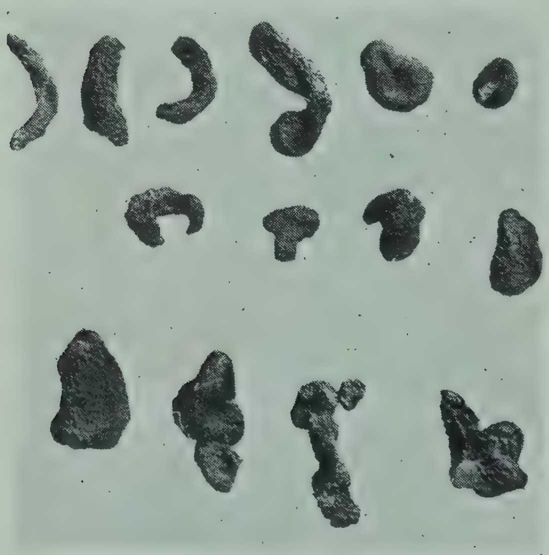

Fig. 125.—Sclerotia of various shapes taken from a diseased lettuce plant.

At the time the wilting appears on the plant the sclerotia have not yet developed, but with the drying out of the decayed tissues numerous coal black bodies irregular in size and shape develop on the surface or within the tissues of the diseased head. These sclerotia might be compared to seeds of a plant in that they are able to preserve the fungus even though they become dried out and are broken up. They retain their vitality for considerable time and when conditions during the following season or year favor their development they are able to produce the fungus which in turn attacks the plants. The season favorable for their development is also favorable for the development of the host plant, and consequently the growth of the two at the same time under the same favorable conditions makes the control of this disease extremely difficult.

CONTROL OF DROP

The application of fungicides is not to be recommended, principally because these plants are usually consumed without cooking in different salad preparations, and also because the fungus is soil inhabiting and attacks the plant from the soil line where it cannot be reached with a spray solution.

It is possible, however, to gain considerable control of drop by the practice of strict sanitation. The entire plant should be removed from the soil at the time it shows the first symptoms of wilting. Such timely removal will prevent the scattering of the later developing sclerotia in the soil and thus remove the source of the spread of the fungus for the following season. It is especially advantageous to practice sanitation on new ground, on sections that are just being prepared for the cultivation of crops attacked by the disease. This practice, though not adhered to at the present time, will undoubtedly be an important factor where truck crops follow each other successively.

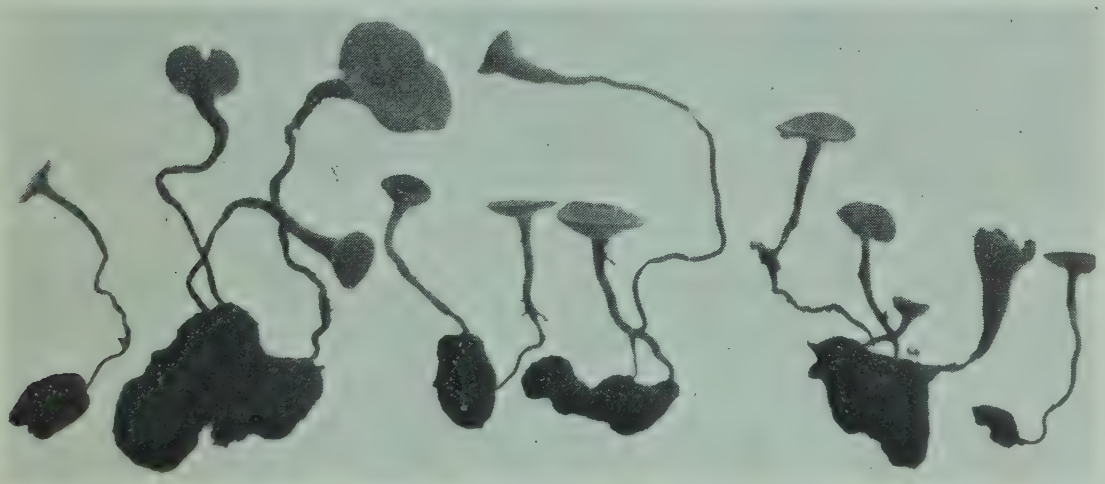

Fig. 126.—Upon germination, the sclerotia develop apothecia. The mushroom-like disks contain the spores of the fungus.

To further eliminate the disease, a very definite system of crop rotation should be followed where possible. If the disease is especially severe, the soil should not be planted to crops attacked by the parasite, but if it is absolutely necessary to plant crops, grow for a fall or spring crop those that are not so severely attacked, such as peppers. Romaine is not so severely attacked as Big Boston, and because of the upright nature of its growth may be found to be a desirable substitute. On badly infested soil it is especially important to discontinue the growth of lettuce, celery, cabbage, eggplants and beans. Seedbed treatment is also extremely important since drop is spread from seedbed to the field at transplanting time.

Seedbed treatment is one of the most important and advisable practices to follow before attempting to grow lettuce. The importance of this will be realized when the grower recognizes that practically all of the lettuce diseases may have their origin in the seedbed. If healthy plants are set in the field, the quick growth of lettuce will usually bring it to maturity before diseases having their origin in the field can cause heavy losses. The treatment of the seedbeds (see page 331) either with live steam, by the inverted pan method, or with formaldehyde not only kills off many of the important soil inhabiting organisms, but also kills weed seeds and nematodes or root-knot organisms, and leaves the soil in a better physical condition.

DOWNY MILDEW

Downy Mildew is caused by the fungus *Bremia lactuca* Reg. It is found in most of the lettuce growing sections of the United States, both under glass and in the field. The occurrence of this disease in Florida is widespread, and in most sections it is considered common.

The fungus attacks all of the specific host plants dealt with in this publication and, because of the extensive planting of lettuce, causes greater losses with this crop than all of the others. It has also been found on a number of the wild host plants belonging to the genera *Lactuca, Sonchus, Gnaphalium,* etc., which abound in Florida in waste places during most seasons of the year, thus acting as centers of inoculum from which the fungus is spread to the cultivated crops. It would be somewhat difficult to make an estimate of the losses resulting from the presence of this disease principally because it is followed up by numerous other organisms that do considerably more damage once they have entered the host plant.

Downy mildew is widely distributed in all sections of Florida, growing in the seedbeds and in the field, and does its greatest damage while the commodity is in transit. Direct losses from downy mildew in the seedbed are seldom serious, but its occurrence there is of considerable importance, since it is spread from there throughout the field at transplanting time. Losses in the field are not of considerable importance in this state, and only occasionally are plants so severely attacked at cutting time, or slightly before, as to cause them to be discarded. In transit the portions of the plant that have been weakened or killed by the downy mildew fungus serve as active centers for the development of other organisms that develop rapidly from the time the plants are packed in the hampers to the time they are sold on the market. This transit loss is usually charged up to the secondary organisms and very little responsibility is placed upon the presence of downy mildew at shipping time.

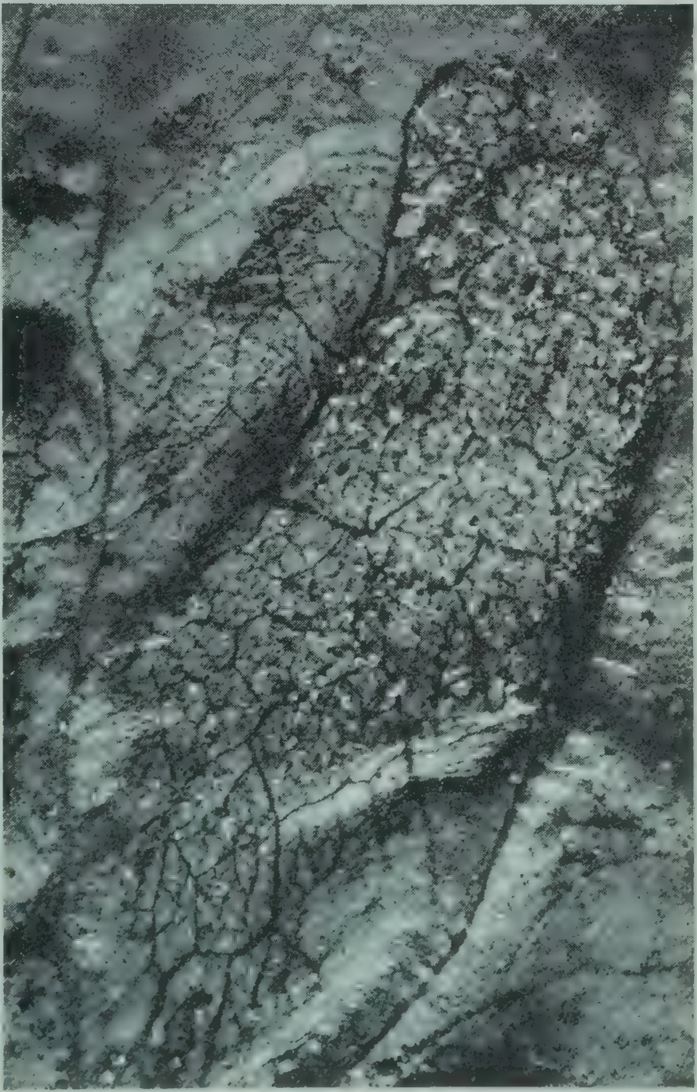

Fig. 127.—Enlarged portion of lettuce leaf, showing downy mildew fungus.

The disease appears in the seedbeds frequently in August or September, but is never abundant at this time. The fall crop of lettuce develops rapidly and it is usually intended that this crop be marketed for the Christmas trade. The downy mildew increases in importance as the weather becomes cooler so that it is an important factor on the early crop. During the winter months the disease becomes more important and occasionally causes considerable loss to the growers. As the weather becomes warmer in the spring the disease appears to be somewhat held in check, and the later crops are usually free from it.

In fields that have been cut over and in which numerous plants have developed seed stalks, considerable amounts of the disease are present, often on the looser leaves and the flowering heads in considerable abundance. This later occurrence, however, is of little direct importance, since lettuce seed is not grown in Florida. However, infected seed stalks act as centers of distribution for the spores.

SYMPTOMS

The downy mildew fungus attacks mainly the older leaves, but may be found on any parts of the plant above ground. It is first evident by the production of a yellowish area on the upper surface of the leaves, and in most instances the corresponding area on the lower surface is covered by a dense, white or grayish, fluffy growth of the fungus which produces the spores. This growth, which is easily detected, is close to the epidermis of the leaf and can be easily removed by brushing the finger over the area. These spots gradually enlarge and, when there are several of them on a single leaf, often coalesce, or grow together. These areas gradually die and become brown, causing the death of the leaves. The fungus also produces spots on the stems of the seed stalk where they are readily seen as irregular, white patches or blotches. The fungus attacks the older leaves first, gradually spreading to the younger growth.

CONTROL OF DOWNY MILDEW

No definite control measures can be recommended, but a few simple and inexpensive precautions such as the spraying of the seedlings the first week they are up with a 4-4-50 Bordeaux mixture, and a later spraying four days before transplanting to the field, will materially check the spread of the disease. It is essential that both lower and upper surfaces be sprayed thoroughly, or results cannot be expected. Sanitary measures should be taken in dealing with this disease. Plants that have not been harvested and seed stalks should be destroyed, so that the fungus will not be able to develop on them. Keep the fence rows and uncultivated areas clean of any of the wild host plants already mentioned.

To avoid further loss during transit, carefully strip off all of the diseased leaves when packing the lettuce.

BACTERIAL DISEASES

The bacterial diseases of lettuce are several in number, as follows: bacterial wilt caused by *Bacterium vitians* Brown; marginal blight, *Bacterium marginale* (Brown); rot, *Bacterium viridilividum* Brown; black rot, *Bacillus lactuca* Vog; rosette *Aplanobacter rhizoctonia* Thomas. The diseases caused by these organisms have been grouped together under the head of bacterial diseases principally because of convenience in handling in this paper and because their general symptoms are so similar.

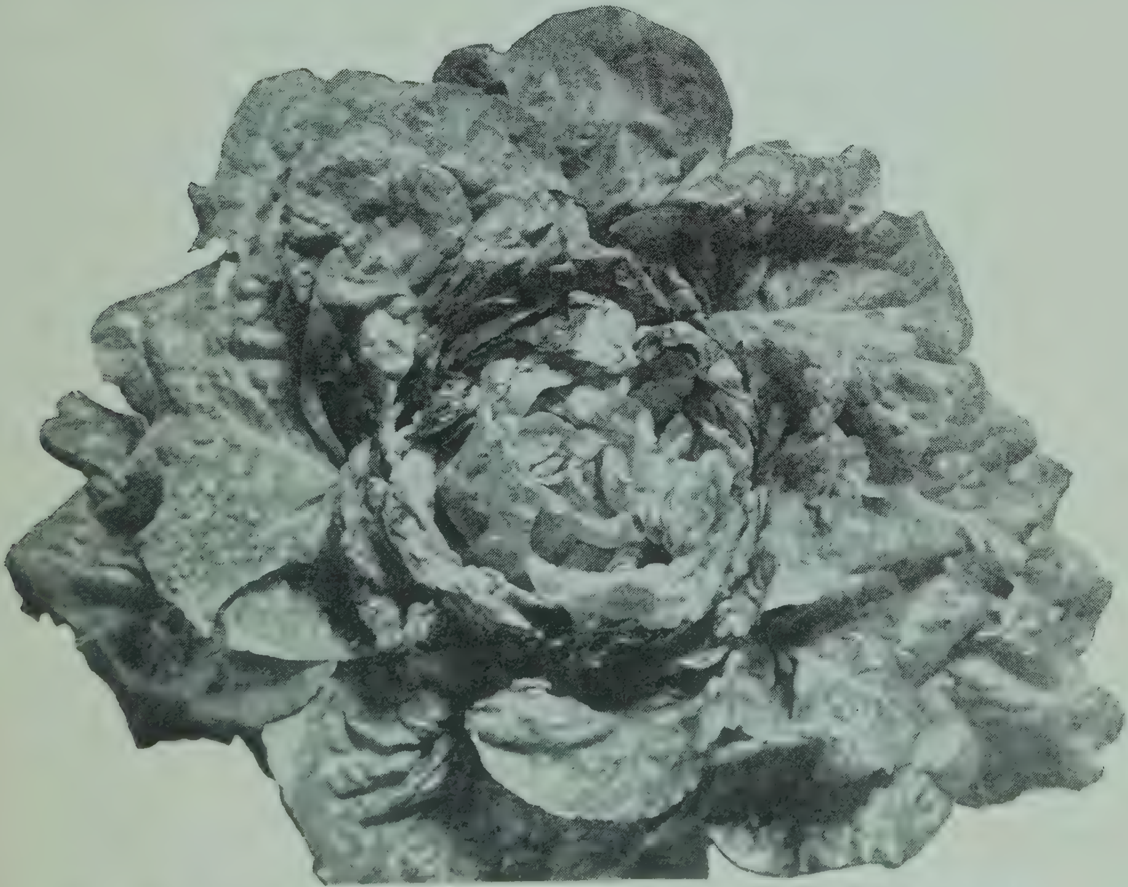

Fig. 128.—Bacterial decay of central leaves of young lettuce plant.

It is necessary to have a specialized training on the identification of these specific diseases to be able to make correct determinations from the symptoms in the field. These diseases are all found on lettuce. None of them have been found on escarole, romaine or endive. These diseases are common in the United States in most sections where lettuce is grown either under glass or in the field. Their occurrence in Florida is as widespread as growing of lettuce. They are common and cause great damage annually in the larger lettuce growing centers.

The host plant may be affected by the disease in all stages of its development from seedling to maturity and in transit. In many fields the loss caused by bacterial troubles is considerable. The greatest losses usually are local in single fields rather than of an epidemic nature in the lettuce growing areas. For instance, in a 10-acre field in 1924 the disease commonly spoken of as "rot" or "black rot" caused an 80 percent loss of plants that were mature enough for harvest.

The losses in the field are only a portion of the ultimate loss due to bacterial organisms. It is an exceptional shipment of head lettuce that does not suffer some loss in transit from bacterial diseases. It is generally understood that only healthy heads are cut and packed, but it is almost an impossibility to detect all infections that may be on the plants and for this reason exceptionally large losses caused by bacterial troubles develop in transit.

These troubles are present in lettuce fields throughout the whole season from the time of planting of seedbeds in the late summer until the last lettuce is cut in the early spring. It is not defiinitely known how the disease is carried through unfavorable periods but it is a general belief that the organisms are capable of remaining viable in green manure not thoroughly disintegrated and in the debris left in the fields following harvesting and that they are in a suitable position to infect plants that are set in the field for the following crop. There are also a number of wild plants closely related to lettuce that grow along the roadsides and ditch banks throughout the whole year which may readily act as hosts to these organisms when cultivated crops are not grown. The organisms are spread during the growing season principally by wind and water. This is particularly true where overhead irrigation is practiced. Their spread also may be accounted for to some extent by cultural practices such as transplanting, cultivating and harvesting.

SYMPTOMS

In general, the common names of bacterial diseases are somewhat descriptive of their general appearance in the field. The wilt disease signifies a general wilting of the plant, a systematic collapse of the leaves beginning with the older ones and continuing to the youngest. This diseases is generally considered as a dry rot or wilt, and not a wet rot, the organism in most cases attacking the lower leaf petioles or the main stem.

The next disease, called "marginal blight," is common on lettuce, affecting the edges of the leaves, causing them to turn brown or blackish over an area several millimeters in depth along the entire edge of the blade. This disease is more of a dry rot and in many cases might be confused with tip-burn. The margin of the leaf becomes dry and if the subsequent season is relatively dry this portion of the leaf falls away, leaving a jagged edge.

Another disease, spoken of as "rot" or "black rot," is characterized by a wet slimy decay and a distinct brownish discoloration. This bacterial disease is probably more important in Florida than all the others combined. Plants that are attacked break down rapidly and eventually become a loose, wet mass on the ground. This disease is often difficult to detect in the field in its early stages. It affects leaves inside the head that are completely covered over with apparently healthy leaves. It can be detected in the field by slight pressure on the head.

The last one of the diseases, commonly known as "rosette," is not common in Florida lettuce fields and from its general appearance would be quite difficult to separate from physiologically stunted plants.

CONTROL

Control methods for bacterial diseases have not been formulated, principally because of the extreme difficulty involved in applying corrective measures. The usual methods for disease control cannot be put into practice effectively because the host plant growing close to the ground does not permit the application of fungicides. The closeness to the soil also conserves the moisture among and under the plants, providing a favorable environment for the development of parasitic organisms. The second important reason why fungicides are not used is because of the discoloring of the plants by the residue from the fungicides. These plants are consumed while still green and fresh, and any foreign material on the foliage reduces their salability on the market.

Consequently, the principal recommendations to be made at this time are to be classed as precautions such as, the choice of soil, drainage, previous rotation, seed treatment or certification, seedbed sterilization, general sanitation in the seedbed, at transplanting time and in the field, care in cultivation, in applying fertilizer and in the process of harvesting, packing and preparation for shipment.

Plants showing leaf spots caused by parasitic organisms or blemishes due to mechanical injury are detrimental to first class packs. The best disease-free seed should be secured from the most reliable seed dealers.

Seedbeds should be free from parasitic organisms. Treat them with live steam or formaldehyde solution.

Practice sanitation by removing all diseased plants from the field.

DAMPING-OFF

Damping-off is a very common trouble of lettuce plants, especially in the seedbed. It is caused by several organisms, each independent or in association with one or more of the others. The organisms most often found concerned with this disease are *Sclerotinia sclerotiorum* (Lib.) Mass., *Pythium debaryanum* Hesse, *Corticium vagum* B. & C., and *Botrytis cinerea* Pers.

This disease is usually very common in seedbeds of all kinds in the United States. In Florida it has been found wherever plants are grown in seedbeds and is of considerable importance. Under favorable conditions practically all seedlings of truck crops are subjected to this disease, and the prevention of it is tied up mostly with cultural practices. It has been found on all types of soils from heavy muck to light sandy, and during all seasons of the year. It is most favored in its development, however, by soil high in humus content, which is very wet during warm seasons.

Many growers overlook the presence of this disease as something necessarily associated with the growing of young plants. They take it for granted that there is to be a certain mortality and do not go further in thought or action as to control. For this reason its importance is often overlooked. In Florida 10 to 15 percent of seedlings are killed off annually because of damping-off, which can, in most cases, be controlled.

SYMPTOMS

Seedlings attacked by damping-off first show a slight drooping at the tips of the cotyledons. At this time examination of the stem will reveal a water-soaked area at or near the surface of the soil. In a few hours the wilting is quite pronounced and is usually followed by the enlargement of the lesions on the stem to such an extent that it is not strong enough to hold the plant erect. When a seedling is killed by one or more of these organisms, it falls prostrate on the ground and is rapidly overgrown by one or all of them.

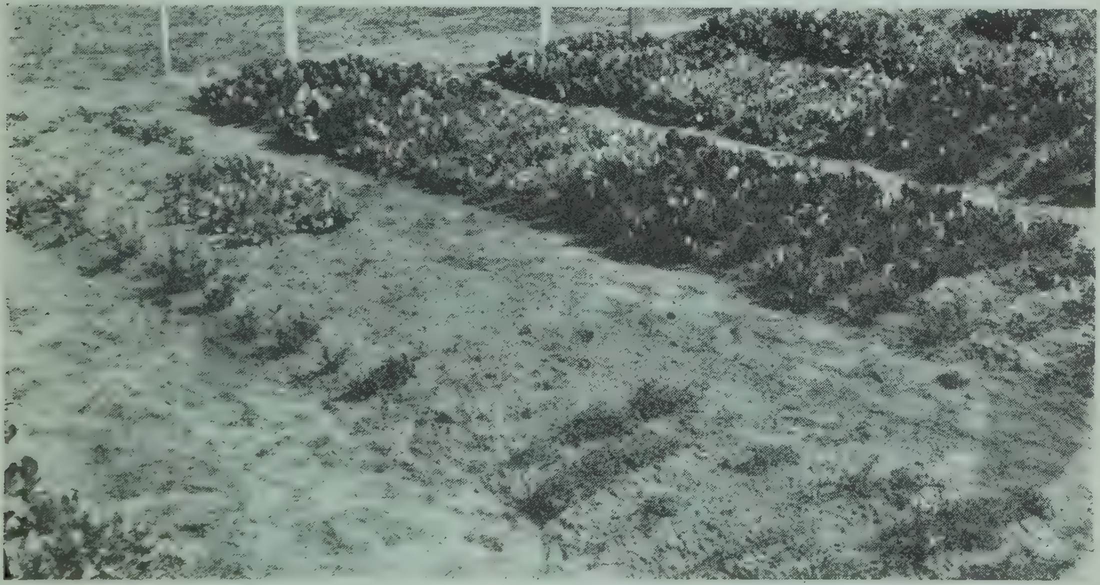

Fig. 129.—Soil disinfection assures the grower of a good seedbed. Damping-off took practically all of the seedlings in the untreated bed in the foreground.

Where the seeds have been planted broadcast, the disease has a tendency to develop more or less in circular patches, killing all of the plants within the circumference, gradually enlarging and including more plants on the edge. In Florida these fungi live in the soil for considerable lengths of time, usually the year around.

The Rhizoctonia stage of *Corticium vagum* is encountered in the seedbeds probably more often than the other organisms. In mild attacks this fungus causes a characteristic browning of the stems at and slightly above the soil line. This attack results in a distinct stunting of the plants and in many seedbeds is the direct cause of the uneven development of the young plants. When the attack is slightly more severe a number of the leaflets become involved and often include all but the undeveloped bud leaf. Plants in this condition often survive the attacks of the fungus and develop eventually into average plants. Often this recovery is associated with a change of environmental conditions, such as temperature, moisture or aeration. When the attack is fatal to the seedlings, they may be killed from the time of seed germination until they are past the transplanting stage. The fungus is evident on the dead seedlings in the form of numerous characteristic chocolate brown undulating, silk-like threads of the size and appearance of coarse spider web.

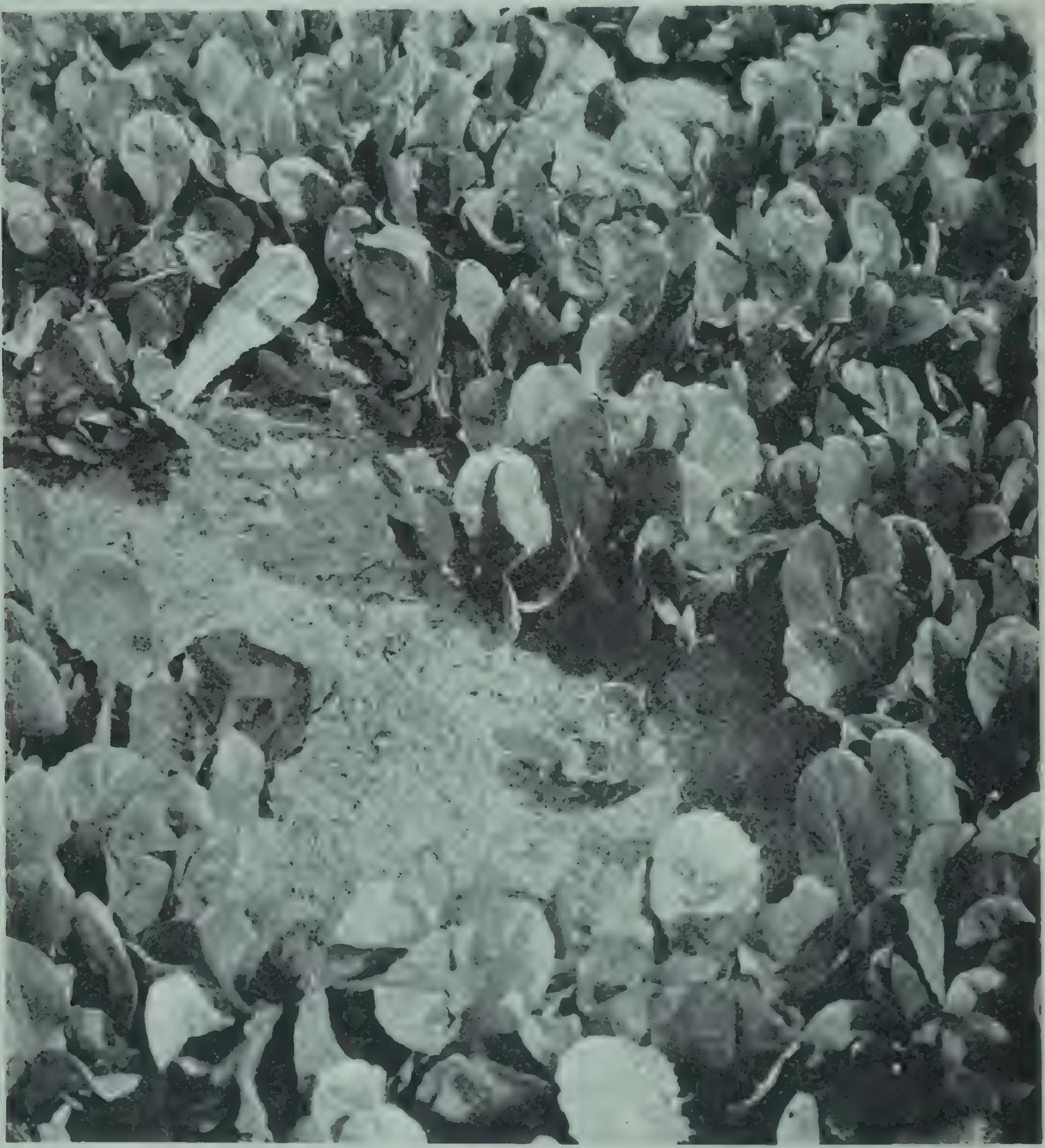

Fig. 130.—Bare spots in escarole seedbeds caused by damping-off in the early seedling stages.

The disease caused by attacks of *Sclerotinia, Botrytis* and *Pythium* are quite similar in their general characteristics. They are very destructive, especially on extremely young seedlings. Once a plant is attacked, it eventually succumbs. The killing of the young plants is rapid, and usually a 24-hour period will be sufficient between infection and death of the plants. These organisms seldom cause a stunting of plants. In seedbeds planted broadcast, the fungi kill the plants in circular areas, gradually spreading from the original point of infection in the center.

CONTROL

Seedbed diseases can be controlled by seed and soil sterilization. There are very few instances where lettuce diseases have been directly attributed to infected seed. However, it would be a precautionary measure to treat seed before planting them. The seedbed can be sterilized with either live steam, formaldehyde or other commercial disinfectants at nominal cost and the soil thus rid of disease organisms. Necessary precautions must be taken following soil disinfection, so that it is not reinfected by tools with which the soil is worked or by laborers walking on unsterilized and then on sterilized soil.

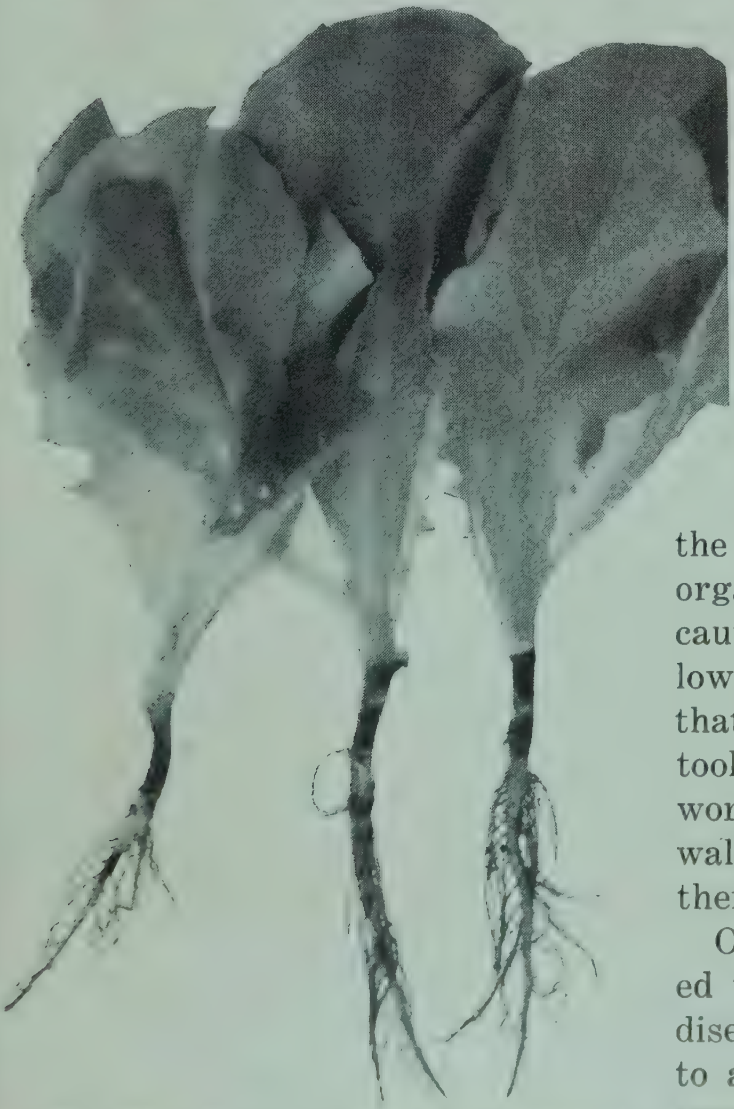

Fig 131.—Lesions caused by rhizoctonia on stems of lettuce seedlings, at transplanting time.

Once a seedbed is infected the development of the disease can be controlled to a certain extent by the proper regulation of irrigation waters. Subirrigation is to be desired or irrigation around the edges of the raised beds. Water should never be applied to the surface of the beds themselves and the plants should never be sprinkled. When a small area in the seedbed becomes infected it would be profitable to remove the soil in it with a small amount of the surrounding uninfected soil from the bed and drench the spot with a formalin solution.

ANTHRACNOSE

Anthracnose is caused by the fungus *Marssonina panattoniana* (Berl.) Mag. It has been known in America for the past 35 years and at the present time may be considered as generally scattered over the lettuce growing regions of the country. It is common in Florida and well distributed throughout the state and has been found on all of the varieties of lettuce usually grown. It does not, however, cause a disease that is of considerable economic importance even though, wherever it is looked for, it can usually be found. It is seldom that one can find a plant that shows more than one or two affected leaves. It also has been found on several wild hosts closely related to these cultivated plants that grow in waste places around the fields. The disease is favored in its development by the cooler parts of the season, it being more important in late fall and winter than early fall and late spring. Moisture relations favorable for the development of the lettuce plants are also favorable for the development of this disease. The spores of the fungus are developed in considerable numbers on the diseased areas and are scattered considerably by wind, rain and running water so that their distribution becomes quite general in a field during a season.

SYMPTOMS

Anthracnose manifests itself first in the form of elongated water soaked areas along the midribs on the lower sides of the older leaves. These spots are slightly yellowish in color and as they enlarge this discoloration becomes more pronounced. They gradually enlarge along the midrib and form the spores in definite spots over the surface of the affected area. The lesions on the blades of the leaf are more circular than the elongated spots on the midribs. The affected tissue of the blades of the leaves is rapidly killed, becomes brown and often falls away, leaving irregular holes in the blade.

Although this disease does not include considerable portions of the plant itself, it is important in transit in that it opens the way for secondary organisms which rapidly involve considerable portions of single heads and result in loss in transit from slimy soft rot.

CONTROL

The most important phase of the control of anthracnose and losses from secondary organisms involves sanitation in the field at harvest time. The primary loss is negligible. When the plants are cut and packed, old infected leaves at the base of the plants should be removed.

Soil sterilization should be practiced in the seedbed. All debris left in the field after the cutting of the crop has been completed should be collected and disposed of by burying in some waste place away from the fields.

GRAY MOLD

Gray mold is caused by the fungus *Botrytis cinerea* Pers. This disease is common in the United States where these crops are grown. It is well distributed over the State of Florida, growing wherever the host plants are grown, but it has never been of considerable importance in this state during any single season nor in any definite locality. The fungus is found on all of the hosts mentioned herein from early fall to early spring and has been found to attack these hosts at all

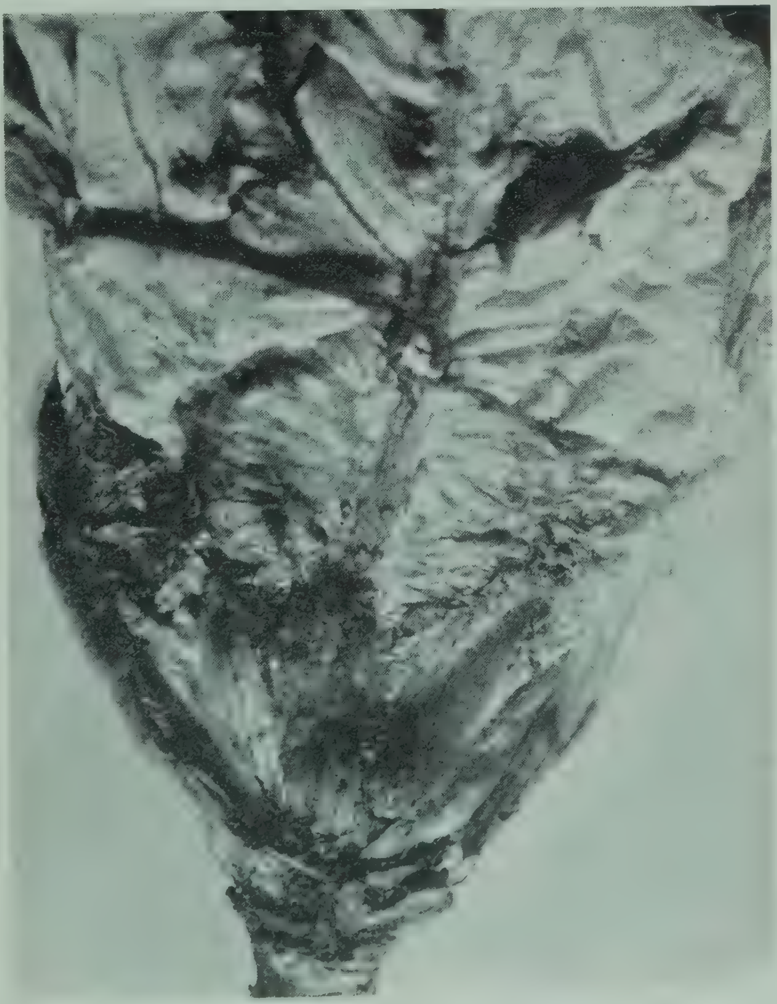

Fig. 132.—Lettuce plant showing an attack of the gray mold fungus.

stages of their development. It has been most common, however, on lettuce and romaine.

It is important on the host plants in the field about harvest time and causes considerable loss in transit when infected plants are included in the pack. The fungus is found in the seedbeds, where it is important primarily because of the possibility of transmitting it from there to the field. The disease develops during the whole growing season.

The fungus produces sclerotia on old plants that are left in the field at cutting time. These sclerotia act in the same way as the sclerotia of the fungus causing "drop." They remain viable during unfavorable seasons and periods when no host plants are grown. When conditions are right for the development of this disease on the plants these sclerotia germinate and develop mycelium and spores of the fungus which attack growing plants, causing the disease.

SYMPTOMS

Water-soaked areas on the lower leaves are first indications of the presence of gray mold. These water-soaked areas rapidly enlarge, often becoming slightly yellowish, and in 24 to 36 hours a fine grayish growth of mycelium appears over the affected surface. This growth of the fungus is essential to the production of spores which appear in the form of small globular masses. These spores are easily detached and scattered by the wind and rain, thus spreading the disease. Often plants are attacked in local areas, causing only a portion of the plant to wilt down, but usually the infection is quite general, causing the plant to wilt in a

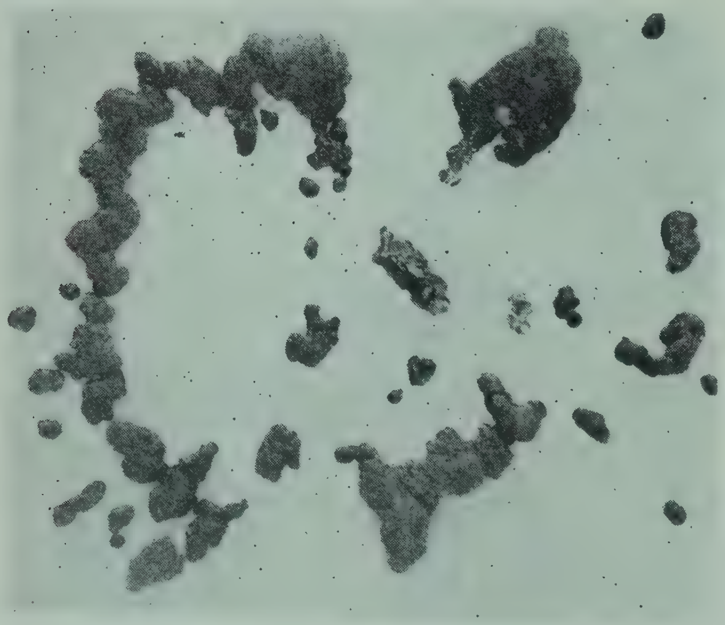

Fig. 133.—Sclerotia of *Botrytis cinerea* Pers. developed in pure culture.

fashion similar to "drop," but not so rapidly. Following the wilting of the plant and its involvement by the fungus it becomes overgrown by the fruiting mycelium, which produces millions of spores. Following this development numerous small black sclerotia are formed which remain after the host tissue becomes dead, brown and dried.

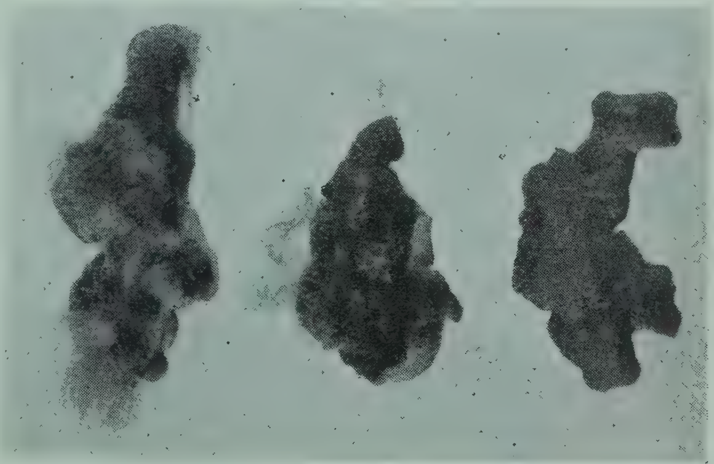

Fig. 134.—Upon germination, the sclerotia of gray mold develop mycelium and spores.

CONTROL

The most important recommendation to be made in controlling gray mold is sanitation in which infected plants are removed from the fields. To prevent losses in seedbeds, spraying the young plants with 2-4-50 Bordeaux mixture is of considerable importance. Rotation is necessary in fields that show considerable amounts of the disease consistently year after year.

BOTTOM ROT

This trouble, which is common in Florida, is caused by the fungus *Corticium vagum* B. & C. It has been reported from some of the eastern states but generally has not been considered common. In Florida this disease is found in all lettuce growing regions and in most places is of some importance, depending on the amount of moisture present. It has been found to attack all of the hosts dealt with here and in addition about 50 other host plants in the state, including seedlings of almost all of the truck crops and annual flowering plants. The most destructive time of the year is during the winter growing season, because of the large acreage. It is more common on muck than sandy soils. Naturally it is more important economically on the muck lands, because 90 percent or more of the truck crop plants are grown on this type of soil.

This disease is not of considerable economic importance even though occasionally it is severe in local areas. It first appears attacking young plants in the seedbed, where it causes considerable loss, depending principally upon the moisture present and

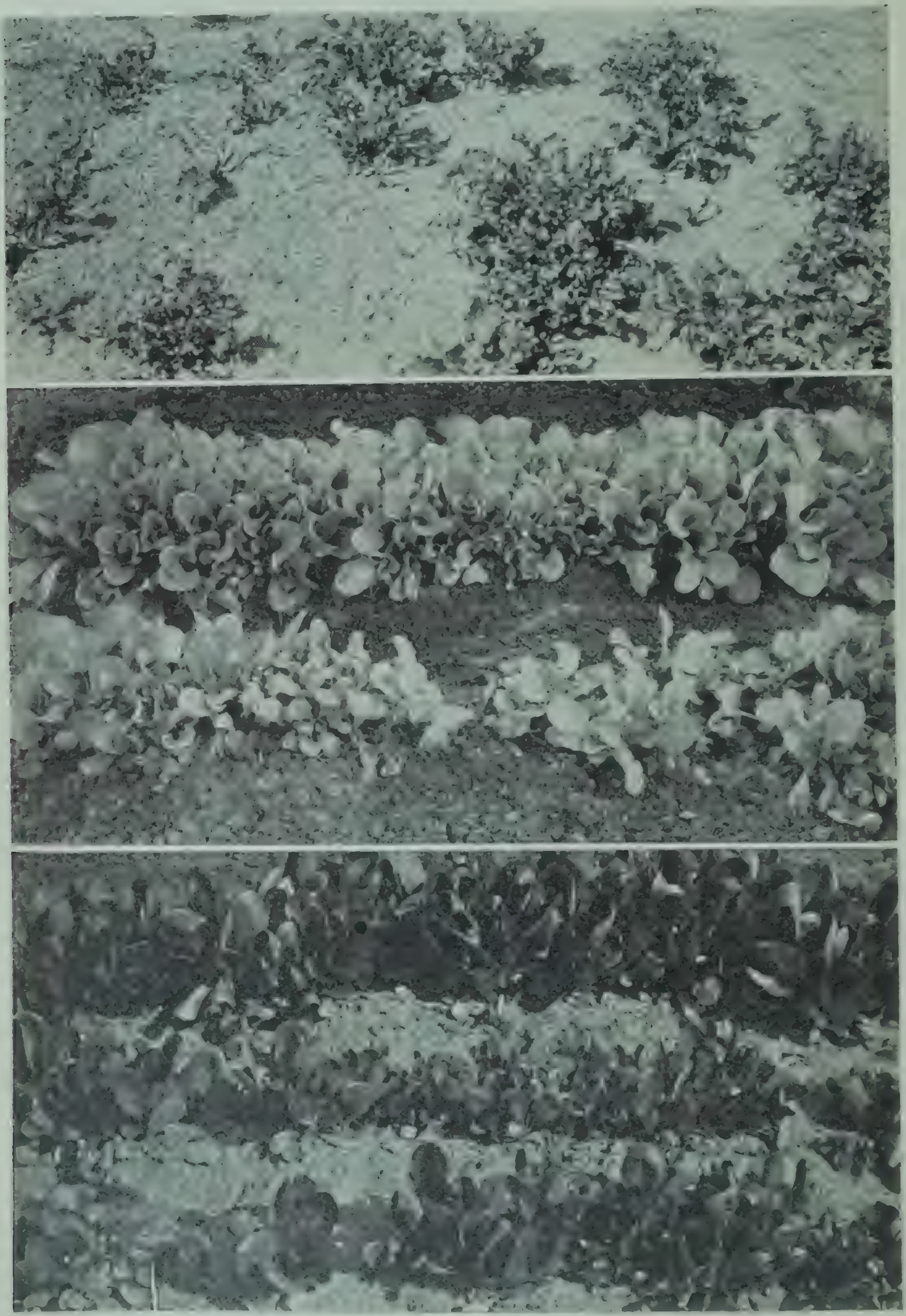

Fig. 135.—Rhizoctonia damping-off and stunting in seedbeds of endive (upper), lettuce (center), and romaine (lower.)

the method of applying moisture to the seedbed. Here it causes a definite damping-off of seedlings. When the fungus attacks plants that have been transplanted to the field it is found most common on the roots and main stem, sometimes also on the lowest leaves that are in contact with the soil. Certain fields during the past season showed as much as 5 percent loss from this disease at harvest time.

SYMPTOMS

A description of the damping-off phase of bottom rot is given under that heading elsewhere. The fungus attacks the roots of the growing plants, turning them brown and killing them, in which instance secondary organisms rapidly cause their disintegration. As new roots are put out the fungus successively attacks them and gradually the plant becomes stunted and finally

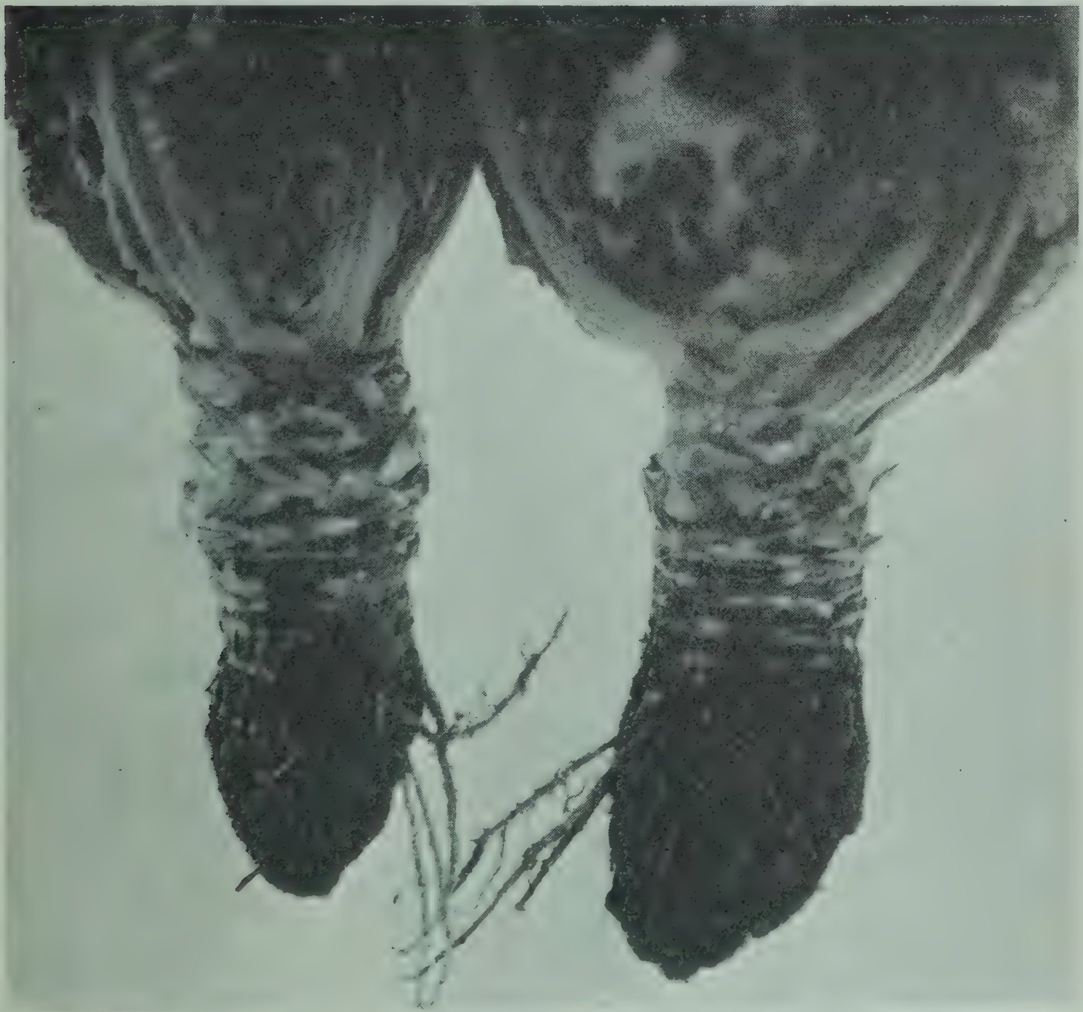

Fig. 136.—Last stages of bottom rot of lettuce caused by *Corticium vagum* B & C.

begins to wilt, showing an appearance similar to "drop" as already described. The wilting is typical of dry weather caused partially from lack of water and probably because of the possible toxic effect of the fungus on the plant. On removing such a diseased plant from the soil, the disease can not be mistaken because of the scarcity of roots and the stubby development of the main stem.

CONTROL

Soil sterilization will control bottom rot but such treatment is expensive and is not to be recommended except in the seedbed. Drainage and irrigation are important factors and should be adequate to handle and control soil moisture.

Spraying or dusting is not to be recommended, since neither has proven entirely satisfactory on plants that are half grown or more. Sanitation and rotation are important in the control of this disease. Plants that show the presence of bottom rot should be removed from the field and other crops should be grown between lettuce crops in an endeavor to prevent the further spread of the disease.

TIP-BURN

This is a physiological condition of lettuce plants which has been found during the later stages of their development, being most serious at maturity or harvest time. The cause is not attributed to organisms, parasitic or otherwise, but rather to the unfavorable environment in which the plant has been growing. This disease is common in the United States where these crops are grown. It is statewide in occurrence and occasionally of considerable importance in Florida. It is more common on lettuce and romaine than on endive and escarole.

Losses from this disease are not important when the lettuce crop is considered in the aggregate, although local fields have been almost complete losses. This condition is generally brought about by fluctuating temperature and moisture conditions. For instance, suppose that for several days the weather is favorable for the growth of the plant, accompanied by high humidity. During this time considerable new tissue develops. Then the weather quickly changes to bright sunshine with less humidity. This results in rapid evaporation from the leaves and dying of the newly developed tissue around the edges of the leaves. This tissue rapidly turns dark brown to black, resulting in the production of the disease.

SYMPTOMS

Tip-burn is characterized by the dark brown discoloration of the margin of the leaves. This discoloration develops rapidly and is readily detected on the plants in a field as the earliest symptoms. In reality it is the killing of plant tissue by drying or burning and does not develop further. This condition usually is found on the looser leaves of the head, although some of the younger leaves completely within the head show disease. It is more common on head lettuce than on leaf lettuce. Very little of the latter is grown in Florida.

CONTROL

Good cultural methods are important in the control of tipburn. Both irrigation and drainage should be well regulated in conformity with the atmospheric conditions. Applications of fungicides, rotation and sanitation have no connection with this trouble, whereas cultivation may be exceedingly important.

MOSAIC

Mosaic is caused by what is generally known as one of the filterable "viruses." It is more common on lettuce and romaine and less common on escarole and endive. It has been observed on these plants in Florida for several seasons and may be considered of more importance in the Sanford section than in any other trucking section of the state. It is not common, even though it is quite generally distributed over this section. The damage it does is slight and by most growers is not considered of much importance.

The disease itself is exceedingly difficult to detect by the ordinary layman and especially before the plant has started to grow after being transplanted to the field.

The general host range of the mosaic disease in Florida is not known at the present time, although it has been found affecting a large number of different plants. This list of host plants includes most of the cultivated truck crops and a large number of wild plants growing in the edges of the fields. It is often thought that these wild plants act as a source of infection for the cultivated plants. They show symptoms of the disease to some extent during almost every month of the year. It is not thought, however, that soil type has any relation to the occurrence of this disease. It occurs on the cultivated crops developing from late fall until early spring.

SYMPTOMS

A diseased plant is easily detected when mosaic is severe because of a distinct green or green and yellow mottling, which usually is found on the leaves previous to heading time. The plants in many instances are extremely stunted. The leaves develop loosely in relation to each other and, in some instances where the disease is severe, are somewhat blasted and seem

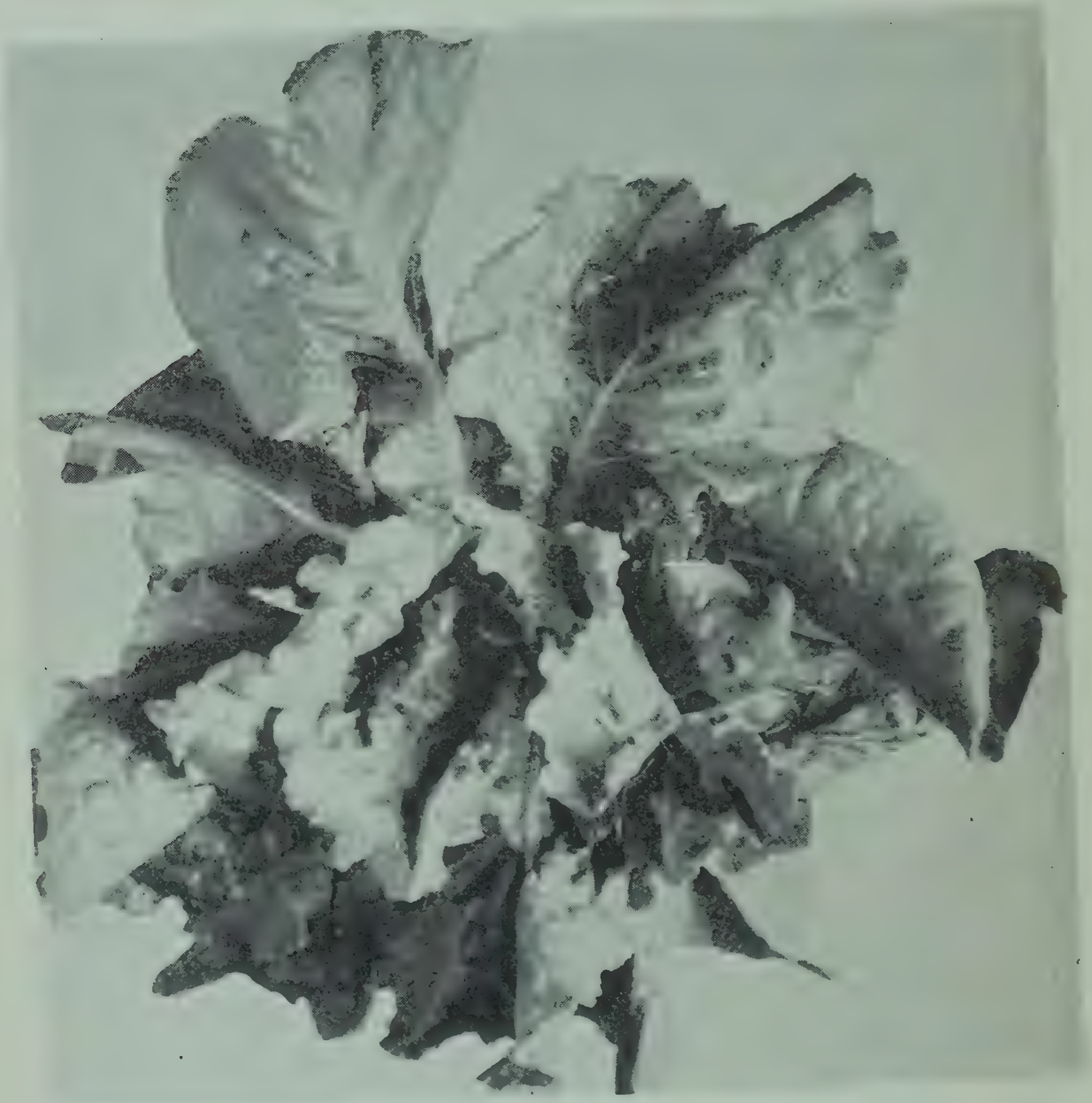

Fig. 137.—Lettuce plant showing characteristic mosaic symptoms.

wilted. Plants that show less distinct mottling are often of a yellowish color, appearing as though they were almost glazed on the surface. The leaves are somewhat harder and more brittle than healthy leaves. Plants that are severely attacked by this disease often fail to head.

CONTROL

Plant only seed secured from the most reliable seed dealers. Remove from the field plants that show mosaic. Control insects which spread the disease in the field, with especial attention to aphids. Care should be exercised in the handling of diseased plants both in the process of removing them from the field and during cultivation. The application of fungicides has no bearing on the control of this trouble. Sanitation, rotation and cultivation are secondary factors in control.

SEEDING

Lettuce growers in the State of Florida are usually well acquainted with the seeding of supposedly head lettuce varieties. The term "seeding" almost explains itself, inasmuch as it refers to the development of lettuce plants that produce seed stalks early in their growth instead of rounding into heads. This phenomenon has been noted particularly in fields of lettuce that have been planted in the late summer and early fall and which develop under exceptionally high temperatures.

There are other probable causes that might hasten the development of the seed stalks in lettuce plants, such as environmental conditions, namely, lack of moisture or lack of plant food. It may also be attributed to a certain extent to cultural methods such as the doubling up of the main roots at the time of planting or the setting in the field of plants that have stood too long in the seedbed. There is a third possibility that the seed planted may not have been true to type or the best strain of the desired variety.

CONTROL

Avoid planting too early in the fall, thus escaping high temperatures. Practice good cultural methods, relating to moisture supply, application of fertilizer and setting and cultivation of plants.

ALTERNARIA BLIGHT OF ESCAROLE

The leaf spots caused by *Alternaria* sp. on this host plant have occasionally been found affecting large areas in certain fields. The disease itself is not considered important, although it has caused in certain instances more damage to this crop than any other disease. The fungus attacks the blades of the leaves, forming small circular spots on them. The centers of these spots gradually dry out, become sunken and turn black. Over their surface the fungus develops spores which are distinctly of the genus *Alternaria*. There is a possibility that with further study it will be found that this organism is the same as the one that causes a similar leaf spot on lettuce.

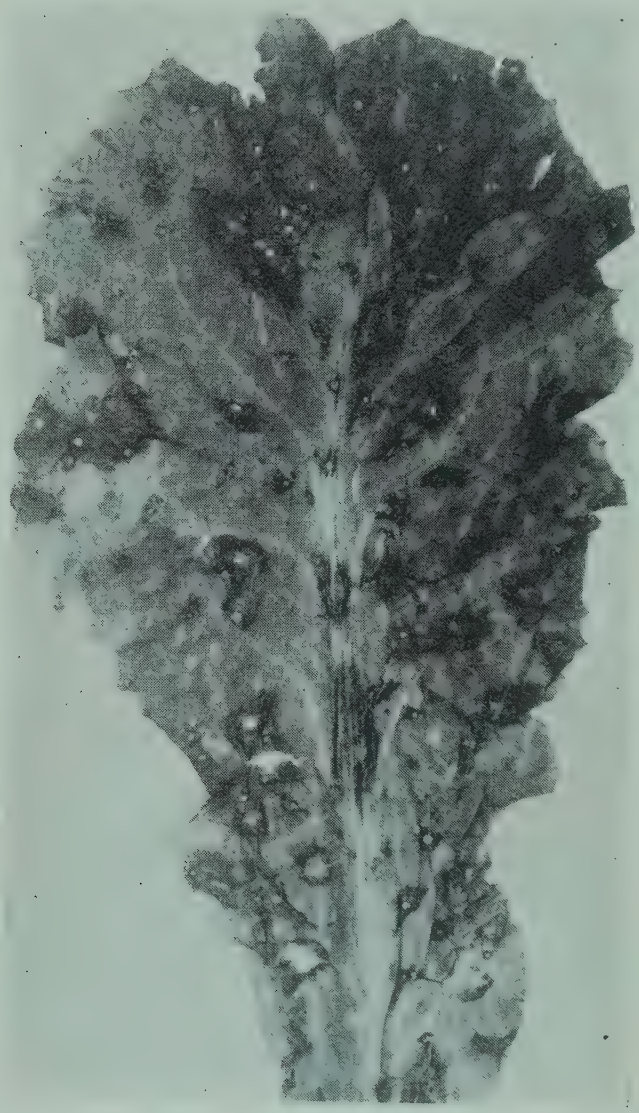

Fig. 138.—Leaf spot of escarole caused by *Alternaria* sp.

CONTROL

Control measures for Alternaria blight of escarole have not as yet been worked out. The application of 4-4-50 Bordeaux mixture is recommended in seedbeds and up until the plants are about half grown. Spraying later may cause discoloration of the plants until harvest time, which is objectionable on the market.

SOUTHERN BLIGHT

This disease caused by *Sclerotium rolfsii* Sacc., has been observed only a few times in the state on any of these host plants.

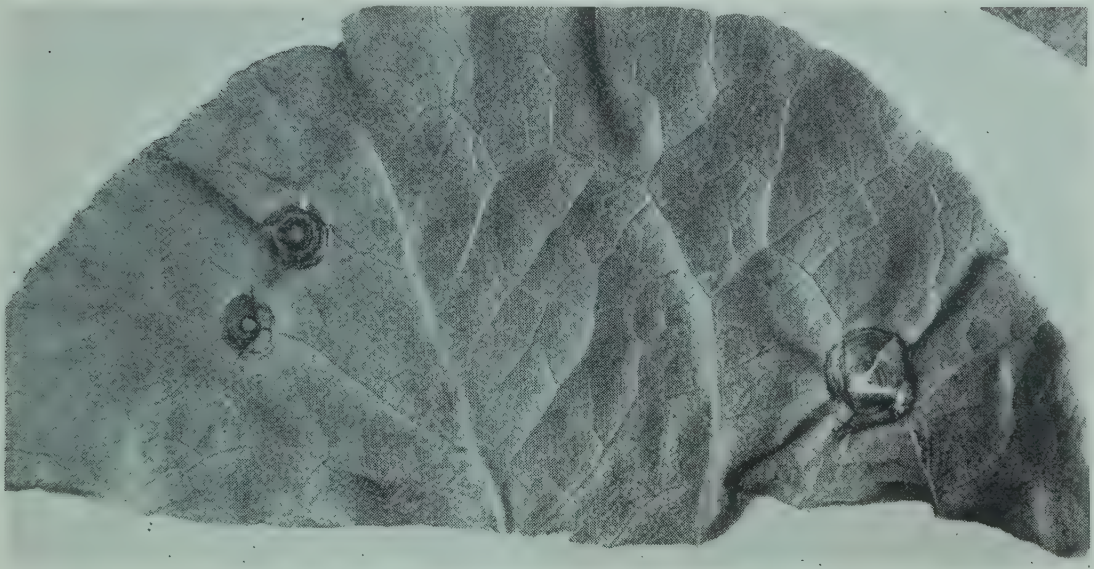

Fig. 139.—Leaf spot of lettuce caused by *Alternaria* sp.

The disease produced is very typical of the diseases produced by this fungus on other truck crops. Because it is so scarce no further details need be given here.

LEAF SPOTS

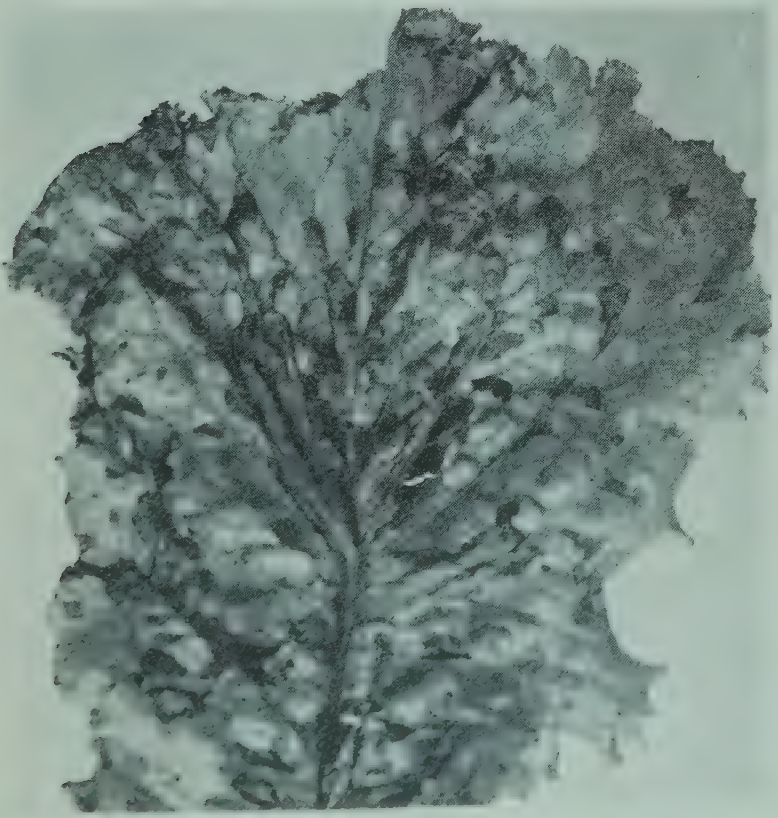

Fig. 140.—Leaf spot of lettuce caused by *Septoria lactucae* (Peck).

Several leaf spots have been collected on lettuce growing in the state. They are of no particular importance from the viewpoint of the growers, inasmuch as they cause no losses and are in most cases entirely overlooked unless one is examining plants for their occurrence. They are of some importance in transit, however, since they open a way for secondary organisms to attack the plants and cause considerable decay.

These leaf spots are distinct and are caused by the organisms *Alternaria* sp., *Septoria lactucae* Pass. and *Cercospora lactucae* Stevenson. The early symptoms of these diseases are quite similar and it is often difficult to tell them apart until after they have enlarged, except by the presence of the fungus and examination of the spores. Of the three listed, *Alternaria* sp. is undoubtedly the most common.

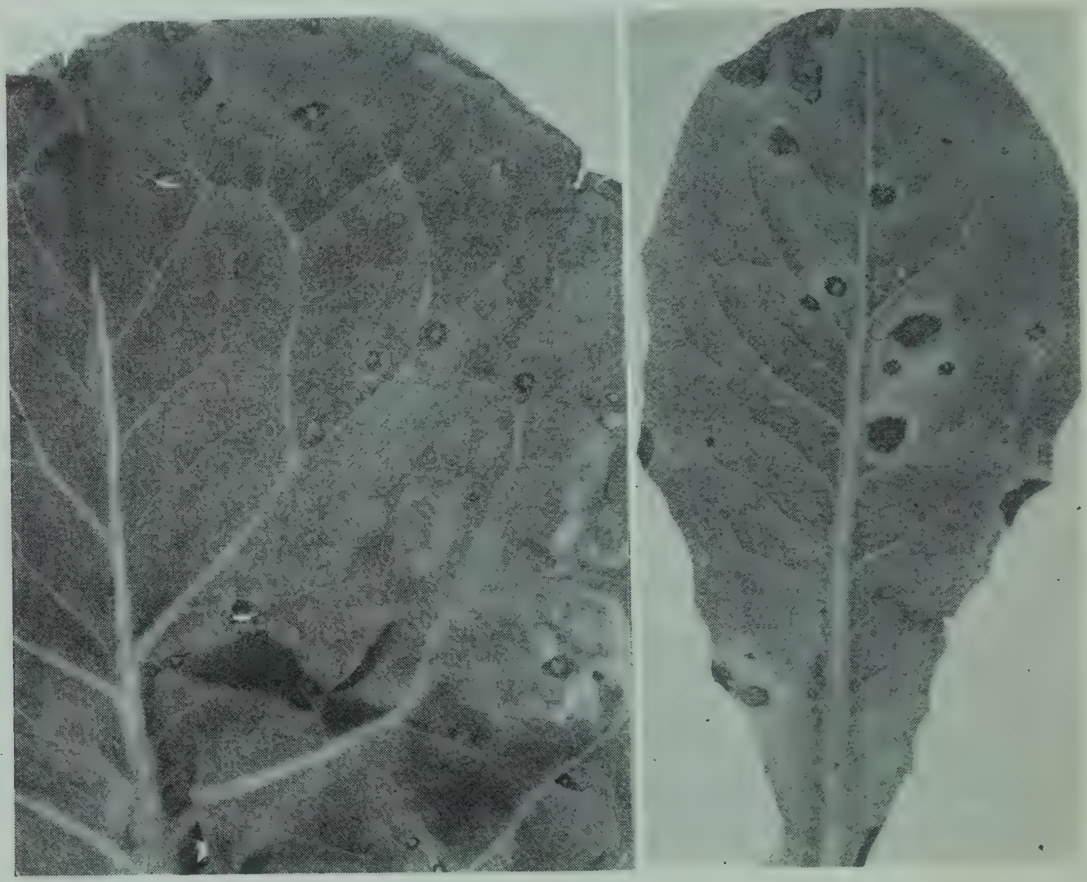

Fig. 141.—Leaf spot of lettuce (left) and romaine caused by *Cercospora lactucae* (Stevenson).

OTHER DISEASES

There have been listed on lettuce in other portions of the United States diseases such as Rio Grande disease, Fusarium wilt, Ozonium and Brown blight. Since these diseases have not occurred in Florida it is not important that they be taken up in general discussion in this paper.

SEEDBED STERILIZATION

It is necessary to combat certain diseases of lettuce in the seedbed, because that is where they first appear and cause considerable loss. Even when the conditions are such that little loss occurs in the seedbeds, there is still the danger of carrying the disease to the field where it might cause damage when conditions are favorable for its development. Then it would be in a position to spread rapidly over the field. In sterilizing the seedbed a thorough job should be done. Two efficient methods of sterilizing soil to be used as a seedbed are given below.

SOIL STERILIZATION WITH FORMALDEHYDE

After the soil selected for the seedbed has been well stirred and loosened, apply a formaldehyde solution made of 8 pints of formaldehyde and 50 gallons of water at the rate of one gallon to one square foot of soil surface. The solution is best applied with a common garden sprinkler. In that way there is little danger of its running into low places before soaking into the soil.

After the solution has been applied the surface of the soil should be thoroughly covered with a tarpaulin, canvas, or burlap bag. This covering prevents too rapid evaporation of the disinfectant. The covering should be left on the soil for at least two days. After that it can be removed and the soil stirred to hasten evaporation of the formaldehyde. Ten days after applying the solution and eight days after uncovering and stirring it, the soil can be prepared and the seed planted.

SOIL STERILIZATION WITH STEAM

This process necessitates the use of a steam boiler of considerable capacity and a rectangular galvanized iron pan large enough to cover a considerable area but small enough to be moved by four men. The pan should have sides six to 10 inches high with sharp edges, so that it can be inverted and pushed down into the soil. In this position it is connected to the boiler by steam hose so that steam from the boiler is discharged into this pan until a potato of medium size buried six inches in the soil under the pan is cooked. Then remove the pan to another portion of the bed and repeat the process. This method is more satisfactory than the formaldehyde method, but it is considerably more expensive. For more information inquire of the Experiment Station.

SEED DISINFECTION

Seed disinfection is recommended to all lettuce growers and should be practiced with every planting. The process is easy and takes only a short time and the results are profitable. In treating the seed all pathogenic organisms adhering to the seed, such as bacteria and fungi, are killed. The seed themselves are not harmed and will germinate almost as quickly and produce as strong plants as those which have not been treated.

The disinfection process is as follows: Place the seed in a cloth bag, tie the top securely, leaving plenty of space in the bag for the seed, for instance twice as much room as the seed occupy. Submerge the bag of seed in a solution of corrosive sublimate, strength 1:1,000, for 10 minutes. During this time it is well to move the bag around in the solution, using a short stick. This will insure the removal of air bubbles so that all seed will come in contact with the disinfectant. After the 10 minute period is up, remove the bag of seed from the disinfectant and rinse in several changes of clear water. After the seed are thoroughly rinsed, spread them out in the shade to dry. When dry the seed are ready to plant.

The container should not be of metal because some of the mercury in the corrosive sublimate unites with the metal, thus weakening the solution and corroding the vessel. Instead, use wooden containers such as pails and half barrels or earthenware crocks.

The disinfectant can be purchased from local druggists and can be obtained in the form of dry crystals or tablets. An ounce of the crystals dissolved in 7½ gallons of water makes a 1:1,000 solution. When smaller quantities of the disinfectant are desired it is advisable to use tablets. One tablet dissolved in one pint of water gives a solution of the strength of 1:1,000. If a gallon of the disinfectant is desired, dissolve eight tablets in a gallon of water.

Corrosive sublimate is a deadly poison when taken internally. Consequently it should be kept away from children and farm animals. When the solution is made up it looks like water, being tasteless and odorless, yet deadly poisonous. Necessary precautions should be taken in disposing of the liquid after it has been used so that nothing will drink it.

Seed may be treated without soaking by the use of different mercurichlorophenol* compounds prepared in the form of dusts. The seed are disinfected by thoroughly mixing certain amounts of them with a specific amount of the dust. The above dusts can be purchased from most seed and spray machine dealers.

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*There are a number of mercurichlorophenol compounds, sold under trade names, used for the treatment of seed of various kinds.

Bulletin 216 June, 1930

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AGRICULTURAL EXPERIMENT STATION
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27.5.52

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A NUTRITIONAL STUDY OF THE WHITE SCHOOL CHILDREN IN FIVE REPRESENTATIVE COUNTIES OF FLORIDA

By
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This investigation was designed to furnish data concerning the health, nutrition, needs, and general well-being of the school children of five representative counties of Florida. The connection between a child's physical condition and his diet is a relation which nutritional workers have recognized and emphasized repeatedly. Therefore, this survey was undertaken in order that better health, more fully developed children physically, and a keener appreciation of nutritional needs would result.

SCOPE OF STUDY

Since many factors are at work affecting the child's well-being, it is necessary to collect data regarding his diet, dietary habits, physical condition, and health habits. These data were obtained by having the following form filled out for each child.

RECORD OF DIETS AND HEALTH HABITS

(Answer all questions and check any point which is true for you.)

Name__________ Address__________ Grade______ Age______ Sex______
Father__________ Address__________

Eating Habits:
Appetite—Good__________ fair__________ poor__________ finicky__________
Eat between meals, yes__________ no__________ habit__________ occasional__________

Food:
Milk: Family uses daily__________ quarts. Uses no milk__________
Vegetables: leafy __________ daily__________ how often?__________
other __________ daily__________ how often?__________
potatoes __________ daily__________ how often?__________

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Fruits: raw ______ daily ______ how often? ______
kinds:
cooked ______ daily ______ how often? ______
Meats: kinds: daily ______ how often? ______
Eggs: daily ______ how often? ______
Cereals: kinds: daily ______ how often? ______
Fats: butter ______ lard ______ oleo ______ other ______
Sweets: candy ______ other ______ how often? ______
Coffee: number of cups ______ strong ______ weak ______ habit ______
occasional ______

Food Supply:
Milk: own cow, yes ______, no ______
buy milk, yes ______, kind: fresh ______, canned ______,
powdered ______
buy milk, no ______
Butter: make ______, buy, yes ______, no ______, substitute, yes ______,
no ______
Vegetables: raise ______ buy ______ canned ______ dried ______ fresh ______

Menus for two preceding days.

Breakfast	Lunch	Dinner	Other

HEALTH HABITS

Care of teeth: owns tooth-brush ______
how often used ______
Cleanliness: wash hands before meals ______, how often bathe ______
Fresh air: windows open nights ______, other means of fresh air ______
Clothing: winter underwear ______, outer wraps ______
wear shoes ______, specify time ______

Further, his physical condition was determined by a medical examination. His record was kept as shown by the following form:

Name ______ Father ______ Address ______
Where born ______ Date ______ Sex ______ Grade ______
Entered school at ______ years. Previous record ______
Nationality of father ______, mother ______
Number of children in family ______

General:
Weight: ______ lbs., height ______ inches.
Nutrition: 1 very fat ______ 2 fat ______ 3 muscular ______ 4 plump ______
5 emaciated ______

Flesh: 1 firm__________, 2 flabby__________

Shoulders: 1 normal__________ 2 round__________ 3 winged__________

Chest: 1 prominent__________ 2 hollow__________ 3 pigeon chest__________

Extremities: 1 bow leg__________ 2 club foot__________ 3 other__________

Spine: 1 curvature__________ 2 lordosis__________ 3 other__________

Speech: 1 stammers__________2 stutters__________ 3 lisps__________

Activity: 1 nervous__________ 2 pepless__________ 3 exhausted__________

Laboratory findings:

Tuberculosis__________Malaria__________Anemia__________Hookworm__________

Other intestinal parasites__________

Medical Examination:

Teeth: 1 carious No.__________2 malocclusion__________3 chalky__________
4 dirty__________.

Gums: 1 gingivitis__________2 pyorrhea__________

Lips: 1 herpes__________ 2 other__________

Nasopharynx: 1 nasal disch.__________ 2 nasal obstr.__________
3 sinus infect.__________ 4 mouth breath.__________
5 chron. nasal catarrh__________ 6 adenoids__________
7 high arch palate__________ 8 tonsils enl.__________disease__________

Eyes: 1 wear glasses__________how long__________ 2 conjunct.__________
3 trachoma__________ 4 vision (a) R. Eye__________
(b) L. Eye__________
5 strabismus__________ 6 ptosis__________ 7 other__________

Ears: 1 hearing R. ear__________ft. L. ear__________ft.
2 otitis (a) chronic__________(b) acute__________ 3 disch.__________

Skin: 1 color (a) yellow__________(b) yellowish-green__________(c) pale__________
2 infect. sores__________ 3 hives__________ 4 ground itch__________
5 scabies__________ 6 boils__________ 7 eczematous__________ 8 dry__________

Abdomen: 1 distended__________ 2 hernia__________

Lymph glands: 1 enlarged, assoc. infect.__________
2 enlarged without assoc. infect.__________
3 cervical__________ 4 axillary__________ 5 inguin.__________

Nervous
System: 1 chorea__________ 2 other__________

Cardiac
Disease: 1 tachyacardia__________ 2 murmur__________ 3 other__________

Pulmon.
Disease: 1 rhythm__________ 2 other__________

Spleen: 1 enlarged__________Thyroid 1 enlarged__________
Anemic__________ Rachitic__________

Remarks:

The various factors, diet, cleanliness, health habits, and physical condition which bear on his progress and development are thus made available for study. Tabulations were made of the records of 3,325 children.

These forms may seem unnecessarily detailed for practical use; however, this is probably the only means of securing sufficiently detailed and accurate information. This arrangement with this number of school children has proved satisfactory in showing large group differences.

THE STAFF

The authors were assisted by the following regular staff: two or more physicians, two or more dentists, two or more nurses, the county home demonstration agents, and the teachers.

The Florida State Board of Health Laboratory made hookworm tests on all of the children.

Blood counts and malarial examinations, when warranted, were made in the laboratories of the Home Economics Department of The Agricultural Experiment Station.

The teachers aided in collecting data concerning the diets and health habits of the children.

The survey met with cordial response from the local organizations. The school officials, civic organizations and the local hospitals gave practical expression of their interest in the work. Interest in the survey was also greatly stimulated by the local press in the respective counties.

SELECTION OF COUNTIES

The counties (*1*)[1] chosen for this survey were selected on the basis of location, each county being representative of its respective section of the state.

County No. 1, Alachua: This county is representative of the central part of Florida, lying north of the citrus section. In this area general farming is practiced, supplemented by truck farming, turpentining and the raising of berries.

County No. 2, Jackson: This county is representative of the northwestern section of the state. The type of agriculture carried on here is general farming, the main crops being cotton, corn and Spanish peanuts. Watermelons were a specialty in some parts of the county. Few fruits or cultivated berries are produced in this area.

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[1] Numbers in italics refer to References in the back of this bulletin.

County No. 3, Hillsborough: This county is representative of the central west coast area. The chief products from this section are: citrus fruits, truck crops and strawberries.

County No. 4, Columbia: This county is representative of the northern portion of the state. In this section the chief occupations of the people are turpentining, lumbering, general farming, with tobacco, berries and nuts as main crops.

County No. 5, Indian River: This county is representative of the central and southeast coast section. The principal industries of this section are vegetable and fruit growing and fishing.

STANDARDS AND METHODS

Uniform conditions and standards were employed in order to secure reliable data. All examinations and measurements were taken by especially instructed persons. This was done to eliminate, as far as possible, personal variations.

VISION

The vision was tested, using the Snelling Chart. The large letters at the top should be read at a distance of 200 feet; the other rows at 150, 100, 75, 60, 45, 30, 25, and 20 feet. The child was placed at a distance of 20 feet from the chart. If he could call the letters on the 20-foot line, he was given a grade of $\frac{20}{20}$. If he could not see that line but could see the larger letters in the line directly above it, he was given a grade of $\frac{20}{25}$. The numerator of the fraction was always the distance between the chart and the child, and the denominator indicated the smallest line which the child could see at that distance. A grade of $\frac{20}{25}$ was considered slightly defective, not necessarily requiring glasses, but the parents were informed to keep the child's vision under observation. A grade of $\frac{20}{30}$ or poorer was considered defective and the parents were advised to have the child taken to a specialist.

In order to standardize the grades and to insure uniform conditions the following details were observed in all cases:

1. The same person conducted all the vision tests.
2. The distance between the child and the chart was 20 feet.
3. A card was used to cover one eye while the other was being tested.
4. The right eye was always tested first.
5. Not much time was spent on the large letters if convinced that the child could see them.

Eyes. In addition to the vision tests already described, the following diseases were looked for: trachoma, conjunctivitis, strabismus, pterygium and ptosis.

An entry was made of all children wearing glasses and the length of time worn.

HEARING

The hearing was determined by the watch tick method. In the hearing test, the child stood nine feet from the person conducting the examination, standing in such a position as to have the ear being tested toward the examiner. His hand was placed over the other ear. After the right ear was tested, the child faced about and the other ear was tested. If the child could not hear at nine feet, he was moved nearer the watch. When he could hear he raised his hand. The distance between the watch and the child determined his grade. The number of feet between the child and the watch was used as the numerator, and nine feet as the denominator. A child hearing at nine feet would receive a grade of $\frac{9}{9}$. One hearing at six feet would receive a grade of $\frac{6}{9}$. Any grade below the latter was considered defective and parents were advised to have the child examined by a specialist.

The use of the "watch tick" method provided a uniform standard for grading.

Ears. In addition to the hearing tests the ears were examined for discharge and chronic otitis.

HEIGHT

In order to obtain a uniform position and standard for the height measurements the following apparatus was used. A smooth board with a strip of paper, marked so as to read in fractions of inches, pasted on it, was used. This board was designed so as to allow it to stand perpendicular to the floor without securing it to the wall. A square could be moved up or down on the scale when reading the height.

The measurement of the height was made by having the child remove his shoes, stand erect, arms hanging naturally at sides, heels together, with the back of his head against the measuring scale. The square was then brought down firmly to the top of his head and the reading was taken.

WEIGHT

All weighings were made on the same scales. Each day the balance was adjusted and corrected. All weighings were taken with the shoes and the outer garments removed.

The height and weight table used as a standard was that given in Holt and Howland (*2*) by Bowditch. Each individual was compared to the average with a corresponding height. If a child was 10 percent below average, he was considered underweight, if 10 percent or more above the average, he was considered overweight.

GENERAL PHYSICAL CONDITIONS

Under the heading of general physical conditions, observations were made of the following: (1) Nutrition, (2) posture, (3) activity, (4) speech.

In the absence of an accepted standard for grading nutrition, a descriptive standard was used. The child was placed in one of the following groups: very fat, fat, plump, muscular or emaciated. In addition to this his flesh was observed and classed as either firm or flabby.

These data, when supplemented by height and weight records, have been used as a criterion of nutrition. The advantage of this method over the method of grouping as excellent, good, fair, poor, and very poor, is that it eliminates the variation due to personal judgment of the observer.

POSTURE

The general appearance with regard to posture is best determined by observation of the following: skeletal outline, shoulders, chest, spine and extremities.

Skeletal outline: There are various defects of each of these bony landmarks which will effect the general physical appearance.

Shoulders: Round shoulders and winged shoulders were looked for in marking this point.

Chest: Observations were made as to prominent, hollow or pigeon-breasted.

Extremities: The following observations were made of the extremities: bowleg, club-foot, knock-knee, and club-finger.

Spine: The spine was checked as to curvature and lordosis.

Activity: The child's vigor was classed under one of the following heads: nervous, pepless, exhausted. This information was obtained from the teacher.

Speech: The following defects of speech were noted: stammering, lisping and stuttering.

MOUTH

The following points were noted on examination of the mouth: teeth, gums, tongue and lips.

Teeth: Here was noted the general condition of the teeth, including malocclusions, number extracted, number of carious teeth, chalky teeth and unclean teeth. Any condition causing an abnormal bite was included under malocclusion.

Gums: Here was noted the condition of the gums as affected by abscesses, gingivitis, and pyorrhea.

Tongue: Here was noted whether the tongue was coated or speckled. The frenulum was also noted when short. This would be a check on conditions of impaired speech as checked in another part of the examination.

Lips: Here were noted color and disease, as herpes or excariation.

NASOPHARYNX

On examination of the nasopharyngeal region the following conditions were observed: nasal discharge, nasal obstruction, mouth breathing, palate, adenoids and tonsils.

Nasal Discharge: The basis for making a positive entry of nasal discharge was: (1) A discharge evident, the condition prevailing for several months. (This history was obtained from the child or the teacher. All children with colds were excluded.) (2) A discharge with marked excariations of the lip.

Nasal Obstruction: This was tested by closing each nostril in turn to see if the child could breathe easily through the open nostril.

Mouth Breathing: This was tested by closing the mouth to see if the child could breathe freely through the nostrils.

Palate: Observations as to cleft palate and high arched palate were made.

Adenoids: Various examiners have various standards which indicate necessity for removal of adenoids. In order to make these results comparable for the children examined in this study the following constituted the basis for recommendation for removal of adenoids: 1. Mouth breathing to such an extent as to cause a facial deformity in absence of nasal obstruction. 2. Chronic nasal discharge (colds excluded).

Tonsils: It is quite impossible to have an absolute standard as to what shall constitute a condition requiring removal of tonsils. The fact that standards do vary among examiners is proved by greatly varying percentages of affected tonsils recorded in various publications. Specialists differ greatly as to what forms an indication for removal of tonsils. With this in mind, definite conditions were designated in this survey, which would constitute a basis which would warrant an entry for defective tonsils. This was done so that all children in this particular group would be judged by the same standard.

1. Greatly enlarged tonsils practically filling the throat, making breathing difficult.
2. Moderately enlarged tonsils with accompanying systemic infection.
3. Moderately enlarged tonsils with greatly enlarged submaxillary glands.
4. Moderately enlarged tonsils with a history of repeated attacks of tonsilitis.
5. Diseased tonsils showing cheesy plugs.

A difficulty which arises in deciding whether removal of tonsils is indicated in examining a group of school children, is that so often no satisfactory history can be obtained. History of previous attacks of tonsilitis and difficulty in breathing are important factors in making a decision. In doubtful cases it was recommended that the child be examined again by a throat specalist. In this study the doubtful cases were not entered and were not included in the general conclusions.

From the indications listed above which warranted removal of tonsils, it is evident that a very conservative standard was maintained.

SKIN

The general conditions—dry, clammy, pale, yellow, etc.—were noted. Also any skin disease was entered when found.

ABDOMEN

Spleen: The subject was examined while standing. The spleen was considered enlarged if the edge could be plainly and definitely outlined at or below the costal margin.

LYMPH GLANDS

The cervical, axillary and inguinal glands were examined for enlargement. They were considered enlarged when they were easily palpable.

HEART

By means of a stethoscope and the radial pulse the heart was examined. A rapid heart, tachycardia and murmur were the defects noted in this examination.

THYROID

The thyroid was considered abnormal when characteristic symptoms were evident and when the gland was easily palpable.

ANEMIA

An anemic condition was determined by observing the color of the lips, the color of the conjuctiva of the eye, and the effect of pressure by the fingers on the lobe of the ear. This was then checked by the use of a Dare hemoglobinometer.

MALARIA

A drop of blood was drawn and placed on a microscopic slide. A microscopic examination was then made of the blood smear to determine the presence or absence of the malarial parasite.

HOOKWORM

During the examination the physical features of the child were observed for symptoms indicating hookworm. These were marked "hookworm suspected" when the conditions warranted it.

In addition to this each child was provided with a container for a specimen of the feces so that a laboratory test could be made for hookworm.

DIETS AND HEALTH HABITS

Methods of Securing Diet Records—Through the help of the teacher, the health habits and the diet blanks were filled out. For the younger children, the blanks were sent home so that the data for the morning and evening meals would be more reliable. The reports were reliable as to the noon meal, for in most cases the teacher supervised the lunch rooms. The child with help of the teacher would list the contents of his lunch box. In other schools, cafeterias were maintained. Thus it was a simple matter to list the menu for the noonday meal. The data for the morning and evening meals were reliable only so far as the child and the parents were able to remember.

Records for the diets of 2,110 children for two days were obtained from four of the five counties.

Limitations of the Data—An effort was made to secure information for all of the points listed in the blank. However, it was found impossible to obtain reliable information in every case. The material thus secured has definite limitations; chief among these are: (1) the data on the food used are not quantitative, except for the amount of milk consumed; (2) the accuracy of some of the data depends on the child's memory and his honesty; (3) the diets represent only two days.

It was impracticable in a survey of this type to attempt the collection of quantitative data on the amount of food consumed, with the exception of the amount of milk used. However, from personal observation at the noon meals, the size of servings of different articles of food, such as cooked vegetables, bread, meat and cake, did not vary much from child to child. Although no quantitative study could be made of these data it was possible to determine much concerning the qualitative adequacy of the diets, since information was available not only as to the kind of food eaten, but also as to the approximate amounts of milk used. Thus the diets were scored on the basis of qualitative adequacy on the assumption that normal amounts of food were eaten.

In considering the third factor which might affect the accuracy of the data the following points should be noted: Although the diets were for only a two-day period, and may have been better or worse than the usual diets for a particular family, these diets can be considered fairly typical, for usually a family has fairly regular dietary habits. Further, diets for Sundays, fast days or any special days were omitted.

It should also be pointed out that the data included diets for the various seasons of the year for each community studied.

The above-mentioned limitations should be borne in mind when considering the effect of diet on the health and state of nourishment of the children. However, when as large number of diets as 4,220 are studied, the trend as to certain relationships between food habits and health should stand out clearly.

EVALUATION OF THE DIETS

In order to compare diets with one another as well as with a fixed standard of adequacy it is necessary to have a system which will represent in terms of numbers, as far as possible, the degree of adequacy of a diet. A general survey of the data was made. It was found that by a division of the material into five recognized types of food all of the individual items of the menu could be tabulated. These different items were then assigned numerical values as shown by Table I.

TABLE I.—VALUE ASSIGNED TO THE FOOD TYPES.

Food	Score
Milk	20
Butter	5
Vegetables:	
Leafy	15
Other	10
Potatoes	5
Fruit:	
Raw, or sugarcane	15
Cooked	5

Bread:	
Whole grain	10
Cereal	5
Meat or eggs	10
	100
Faulty dietary habits, deduct	10

The preceding values represent the optimum score for the diet of one day. The scores are based on an average quantity and daily use of each item.

The authors realize that by this method of evaluating the diets a certain degree of arbitrariness is introduced. However, it has been found, as pointed out by Davies (*3*), that this method not only facilitates the work of evaluating the diets of different character but also results in total scores which permit comparisons of the different diets recorded as to the degree of adequacy or inadequacy.

The scores for diets were then studied and grouped under the following heads: (1) extremely deficient, (2) inadequate, (3) questionable, (4) adequate, and (5) commendable. The numerical values of these groups are as follows: extremely deficient, 5-15; inadequate, 20-35; questionable, 40-55; adequate, 60-80; commendable, 85-100. The adequate class covers all the needs for growth and maintenance but is not free from some objectionable dietary habits. Of these, the following are the most common: promiscuous eating between meals, unsuitable desserts, improper arrangement of schedule, such as the heaviest meal at night and irregular times for meals. In the commendable type there are the diets which are adequate and free from the abovementioned faults.

A further study of the diets was made to evaluate the menus for each meal during the day. These were scored in a similar manner as the diets for the entire day. Tabulations were also made to show the frequency with which specified foods appeared in the menus.

FINDINGS

A record was made in this way of the physical defects and the dietary habits of each child. The defects of each were then tabulated and studied under the following headings:

1. Prevalence of defects of all children examined.
2. Prevalence of defects of all children by sex.
3. Prevalence of defects of all children by age.
4. Prevalence of defects among underweight children.

5. Prevalence of defects among hookworm children.
6. Prevalence of defects among anemic children.
7. Prevalence of defects among children with abnormal tonsils.
8. Relation between weight and hookworm.
9. Relation of diet to underweight children.
10. Relation of diet to overweight children.
11. Relation of diet to anemic children.
12. Relation of diet to teeth.

PHYSICAL FINDINGS AND DIET

Several methods were used in this study in an effort to determine whether or not any definite relation could be established between food habits and the state of health of the children.

The physical findings for all the children examined have been tabulated. Diets were obtained from slightly over 60 percent of the 3,444 children who were given physical examinations. Complete data were not obtained for the 3,444 children. In 247 instances age was not given; in other cases either height or weight was not given. However, complete data were obtained for 3,325 children with the exception of age and diet.

Of that group of children from whom diets were obtained and who were given physical examination the following study was made:

First, the relation of factors other than diet which might affect weight and general health.

Second, the records of the diets of all children examined were compared with the diets of those underweight, overweight and of normal weight.

Third, the relation of anemic conditions to diet.

Fourth, the conditions of the teeth were studied with respect to diet, especially the use of milk.

PHYSICAL FINDINGS IN GENERAL

Table II shows the presence of defects of all children examined in this survey. In general it will be noted that: (1) The defects of the boys are of a higher percentage than those of the girls. The large proportion of boys with defective tonsils, defective teeth and hookworm accounts largely for this variation. (2) A very favorable showing was made for the children without defects. The girls, of whom 5.9 percent were without defects, made a better showing than the boys, with 5.1 percent free from defects. (3) Defects of naso-pharyngeal region are the most conspicuous of the entire group.

TABLE II.—PREVALENCE OF DEFECTS BY SEX OF ALL THE CHILDREN EXAMINED.

Defects or Disease	**Both Sexes**		**Boys**		**Girls**	
	No.	%	No.	%	No.	%
TOTAL	3,444		1,625		1,819	
Complete examination	3,325		1,577		1,748	
Total number weighed	3,027		1,415		1,612	
Without disease	184	5.5	80	5.1	104	5.9
GENERAL						
Underweight (10% and over)	977	32.3	431	30.5	546	33.9
Overweight (10% and over)	380	12.5	140	9.9	240	14.9
Anemic	1,282	38.6	630	39.9	652	37.3
EYE DEFECTS						
Defective vision	886	26.6	452	28.7	434	24.8
Conjunctivitis	1,012	30.4	512	32.5	500	28.6
Strabismus and other eye defects	72	2.2	35	2.2	37	2.2
EAR DEFECTS						
Defective hearing	247	7.4	146	9.3	101	5.8
Other ear defects	59	1.8	34	2.1	25	1.4
MOUTH						
Decayed teeth	1,520	45.7	807	57.2	713	40.8
Malocclusions	400	12.1	235	14.9	165	9.4
Gingivitis	394	11.5	182	11.4	202	11.6
NASO PHARYNX						
Tonsils (defective)	1,637	49.2	824	52.2	813	46.5
Adenoids (suspected)	586	17.6	290	18.4	296	16.4
Nasal obstructions	331	10.0	178	11.3	153	8.8
GLANDS						
Cervical (enlarged)	1,279	38.5	666	42.2	613	35.1
Thyroid (enlarged)	77	2.3	9	.6	68	3.9
HEART DEFECTS	423	12.7	181	11.5	242	13.8
SKIN						
Eczema	29	.9	13	.8	16	.9
Acne	17	.5	7	.4	10	.6
Impetigo	167	5.0	88	5.6	79	4.5
Infected sores	145	4.4	88	5.6	57	3.3
Scabies	27	.8	10	.6	17	1.0
Dry	180	5.4	86	5.5	94	5.4
Yellow	222	6.7	125	7.9	97	5.5
ABDOMEN						
Distended	403	12.1	222	14.1	181	10.4
Enlarged spleen	129	3.9	84	5.3	45	2.6
Hernia	10	.3	10	.6	...	....
PARASITES						
Hookworm	1,565	47.1	845	53.6	720	41.2
Tape Worm	11	.3	7	.4	4	.2
Ascaries	17	.5	10	.6	7	.4
BONY SYSTEM						
Pigeon breast	35	1.1	21	1.2	14	.8
Round shoulders	392	11.8	202	2.8	190	10.9
Winged scapulae	62	1.9	28	1.8	34	1.9
Rickets	2	*	2	.1	...	....
MALARIA	8	.2	4	.3	4	.2
SPEECH	62	1.9	28	1.8	34	.9

---

*Less than 0.1 percent.

PHYSICAL FINDINGS

EYES

Vision: Table III gives a summary of the findings with regard to the eyes. It was possible to test nearly all of the children by the Snelling chart. In the first grades, the illiterate chart, as described by Rude (*4*), was used, in case the child did not know the letters.

Out of the 3,325 children given the vision test 26.6 percent showed defective sight of varying degree. The degree of abnormality of vision varied from slightly defective to seriously defective in one or both eyes, and even blindness in some few cases. Children already wearing glasses were tested with their glasses on, and many were found to have defective sight, even after attention had been given their eyes.

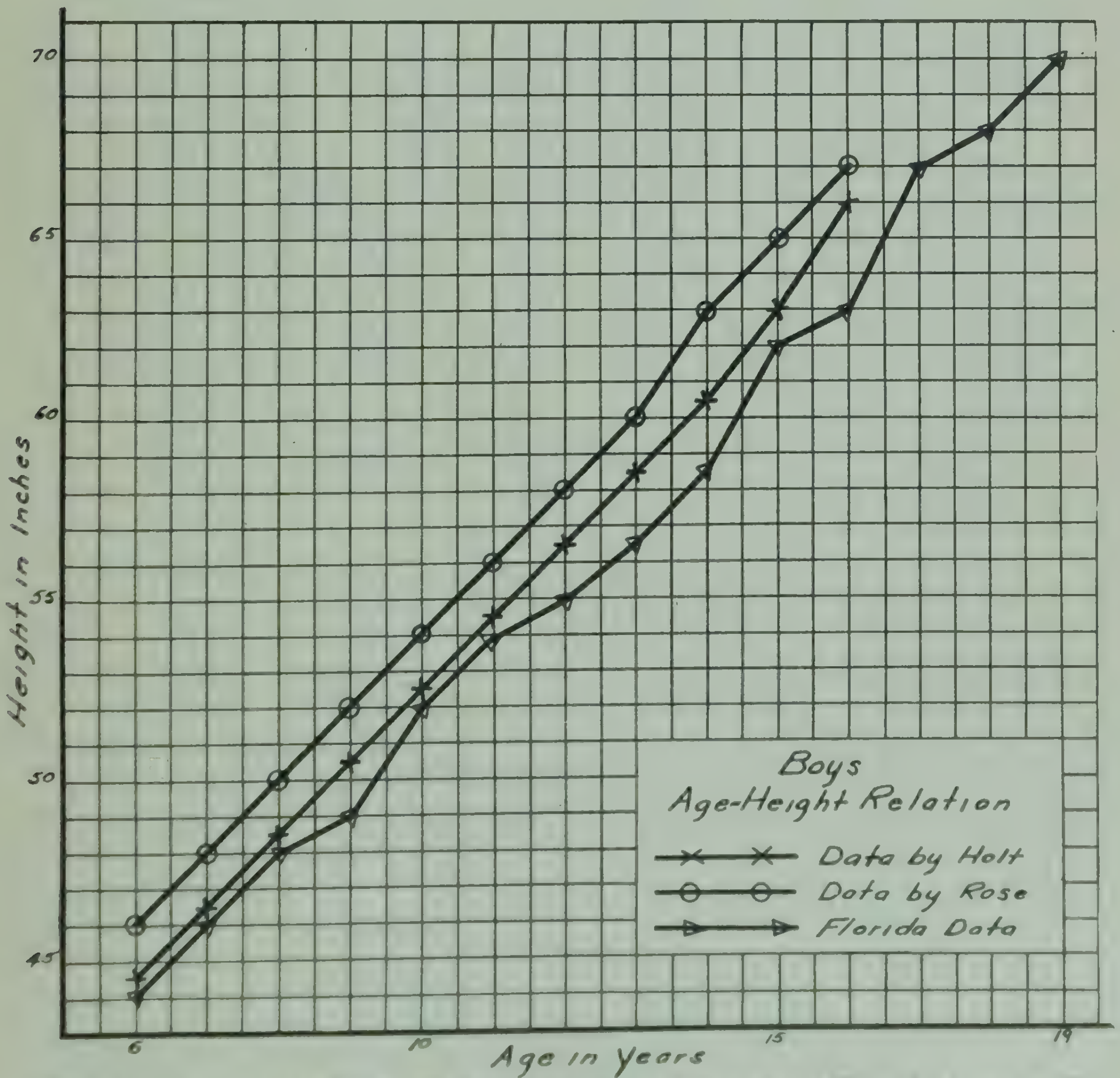

FIG. 1.—Comparison of the average height for age of Florida boys with standards.

Apparently there is no significant relation of defective vision to age. However, it is worthy of comment as shown by Table V that at the age of six or seven, the percentage with defective vision was lower than between the ages of 8 and 15. From the ages of 15 to 19 the percentage decreased again.

Conjunctivitis: The high percentage of children having conjunctivitis, 31.0 percent, is an outstanding condition found in this study.

Strabismus: Strabismus was found in 6.1 percent of all the children examined. Of these, 14 children had corrective glasses.

Trachoma: Trachoma was found (and corroborated by a specialist) in three children.

A summary of the eye condition is found in Table III.

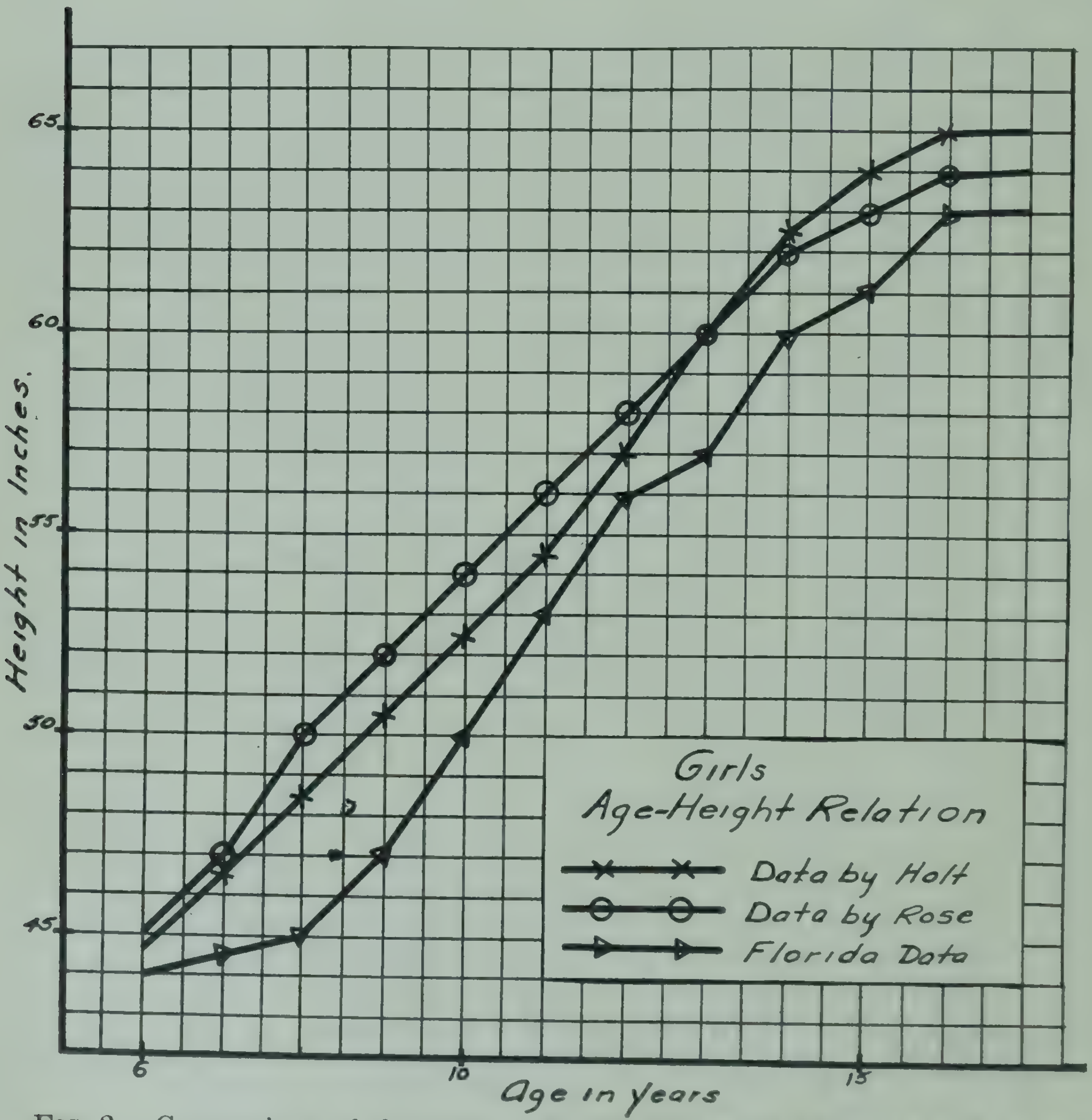

FIG. 2.—Comparison of the average height for age of Florida girls with standards.

TABLE III.—EYE DEFECTS OF CHILDREN EXAMINED.

	Total		Boys		Girls	
	No.	%	No.	%	No.	%
Vision tested	3,325		1,577		1,748	
Normal	2,439	73.4	1,125	71.3	1,314	75.2
Defective	886	26.6	452	28.7	434	24.8
Seriously defective	144	4.3	81	5.1	63	3.5
Blind in one eye	12	0.4	7	0.5	5	0.3
Conjunctivitis	1,012	30.4	512	32.5	500	28.6
Strabismus	61	1.8	33	2.0	28	1.6
Sty	10	0.3	6	0.4	4	0.2
Ptosis	5	0.1	2	0.1	3	0.1
Pterygium	4	0.1	2	0.1	2	0.1
Trachoma	3	0.1	2	0.1	1	0.1

EARS

The total number of cases of defective hearing was 247, or 7.4 percent of all those examined. Of these 64, or 26 percent, were associated with earache and tonsilitis. The distribution by sex, as shown in Table II, parallels the distribution by sex of defective tonsils, the boys showing a larger percentage of defects of hearing than the girls.

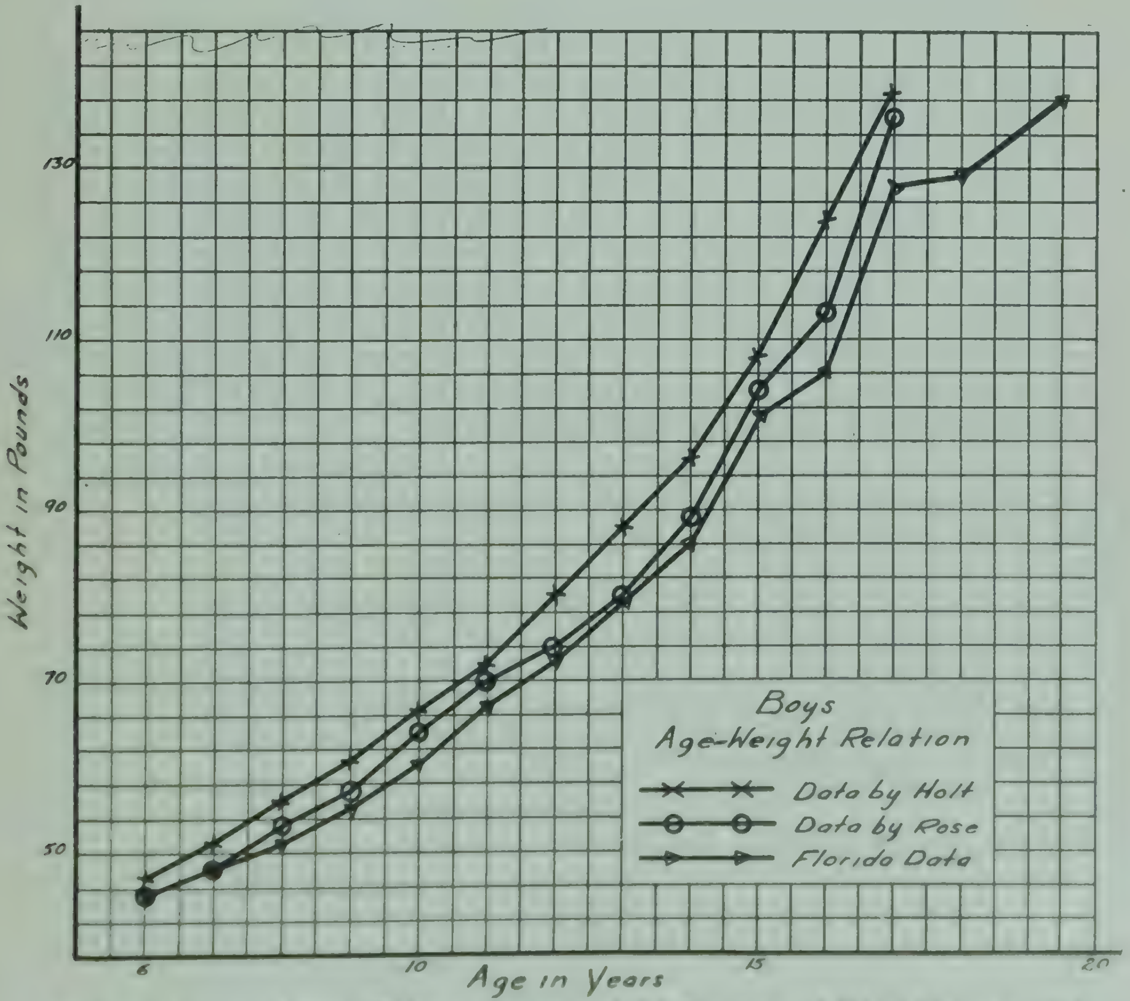

FIG. 3.—Comparison of the average weight for age of Florida boys with standards.

Aside from defective hearing, 59 cases of chronic otitis were recorded.

HEIGHT AND WEIGHT

The average height and weight relation for each age of the children examined in this study is given in Table IV. The values represent the weight of the children with outer clothing and shoes removed. Figures 1 and 2 show a comparison of the average height with age for boys and girls, respectively, with the figures of Crum and Bowditch, which were used as a standard. The average height for age is lower throughout than the standard. The figures obtained are also lower than the values given by Rose (5) as shown in Figs. 1 and 2.

The weight plotted against age is given in Figs. 3 and 4. These figures show that the average weight for a given age is lower than the values given by Bowditch or by Rose.

Figures 5 and 6 give the result of the height-weight relation for the children examined in this study, and also the values given by Bowditch and those given by Rose. These values do not show as great a variation from the standard as do either the height-

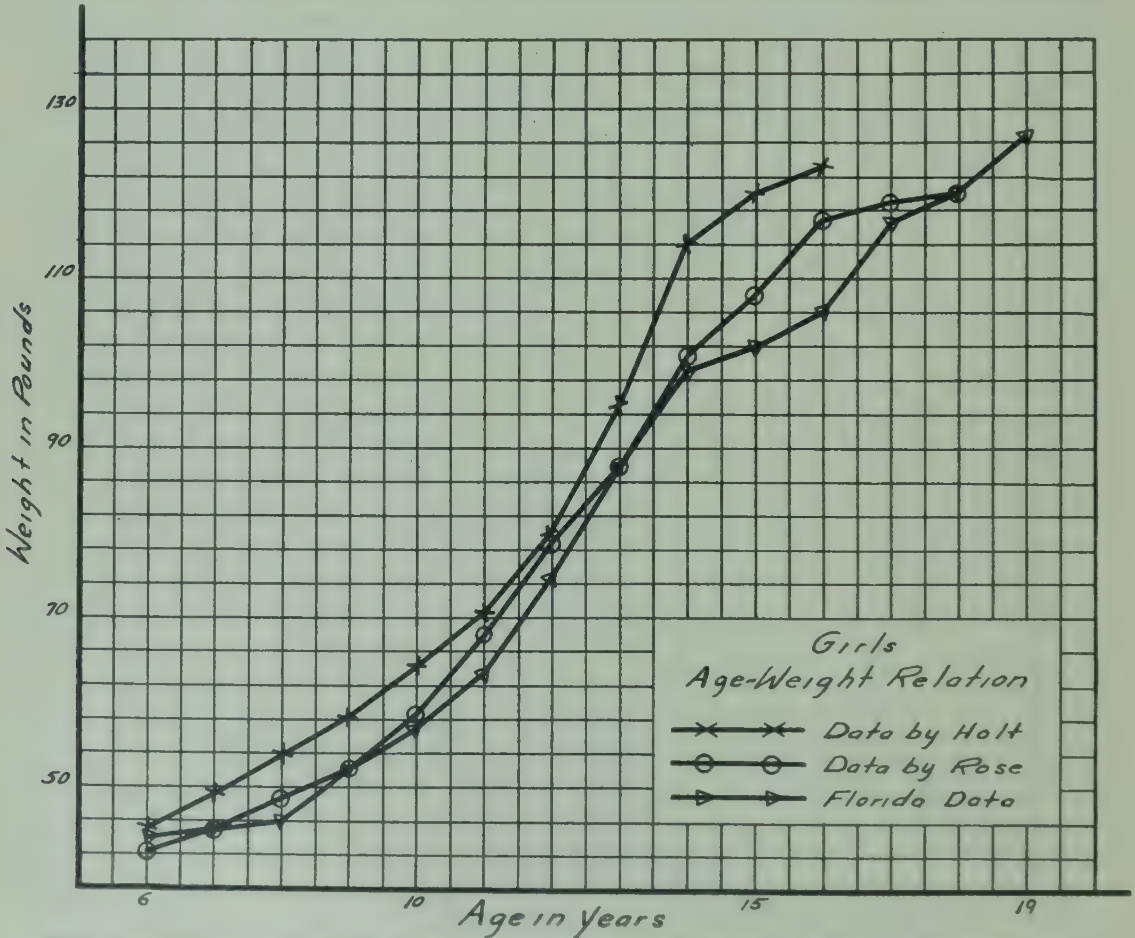

FIG. 4.—Comparison of the average weight for age of Florida girls with standards.

age relation or the weight-age relation. However, Fig. 5 shows a marked retardation in development of the boys between the ages of seven and eleven years and after the eleventh year they practically coincide with the standard. Fig. 6 shows a retardation among the girls at about the same age. A possible explanation of this is found in Table V, defects by age. Hookworm infestation is the heaviest between the ages of 8 and 12 years. This should be considered as one of the factors which influence development.

GENERAL PHYSICAL CONDITION

Included in this group were the following defects: round shoulders, winged scapulae, pigeon breast, bony defects of rachitic origin, and impediment of speech. According to Table II, no marked variation with respect to sex can be found.

Round shoulders were recorded when the condition was marked enough to produce a hollow chest. This condition far exceeded all other defects of posture.

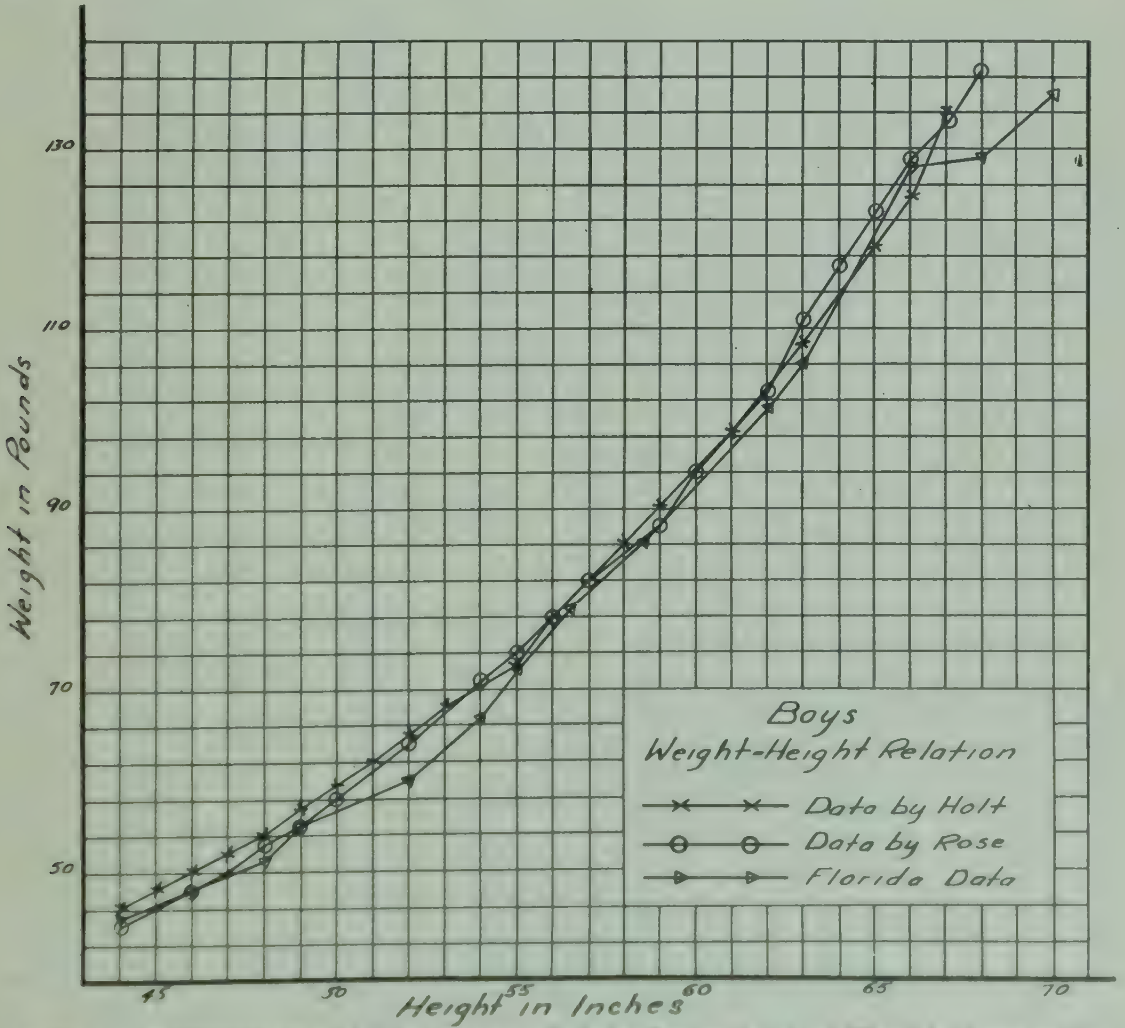

FIG. 5.—Comparison of the average height for weight of Florida boys with standards.

Only two cases of bony defects of rachitic origin were found. These conditions consisted of beaded ribs, enlarged epiphyses, a large square head and a pronounced condition of knock-knees.

Functional speech defects were noted in 1.6 percent of the children, practically equally distributed according to sex. These defects were stammering, stuttering and lisping.

Prevalence of Defects by Age: In Table V the defects are given by age. Of the 3,444 children examined the age for 3,202 of the group was recorded. An analysis of Table V shows some relationships of the various defects to age. Underweight was found more prevalent among the boys between the ages of 10 and 16 while the girls showed a greater tendency to underweight between the ages of 11 and 14. Anemic conditions of boys were found most frequently between the ages of 11 and 16 while the greatest number of anemic girls were found between the ages of

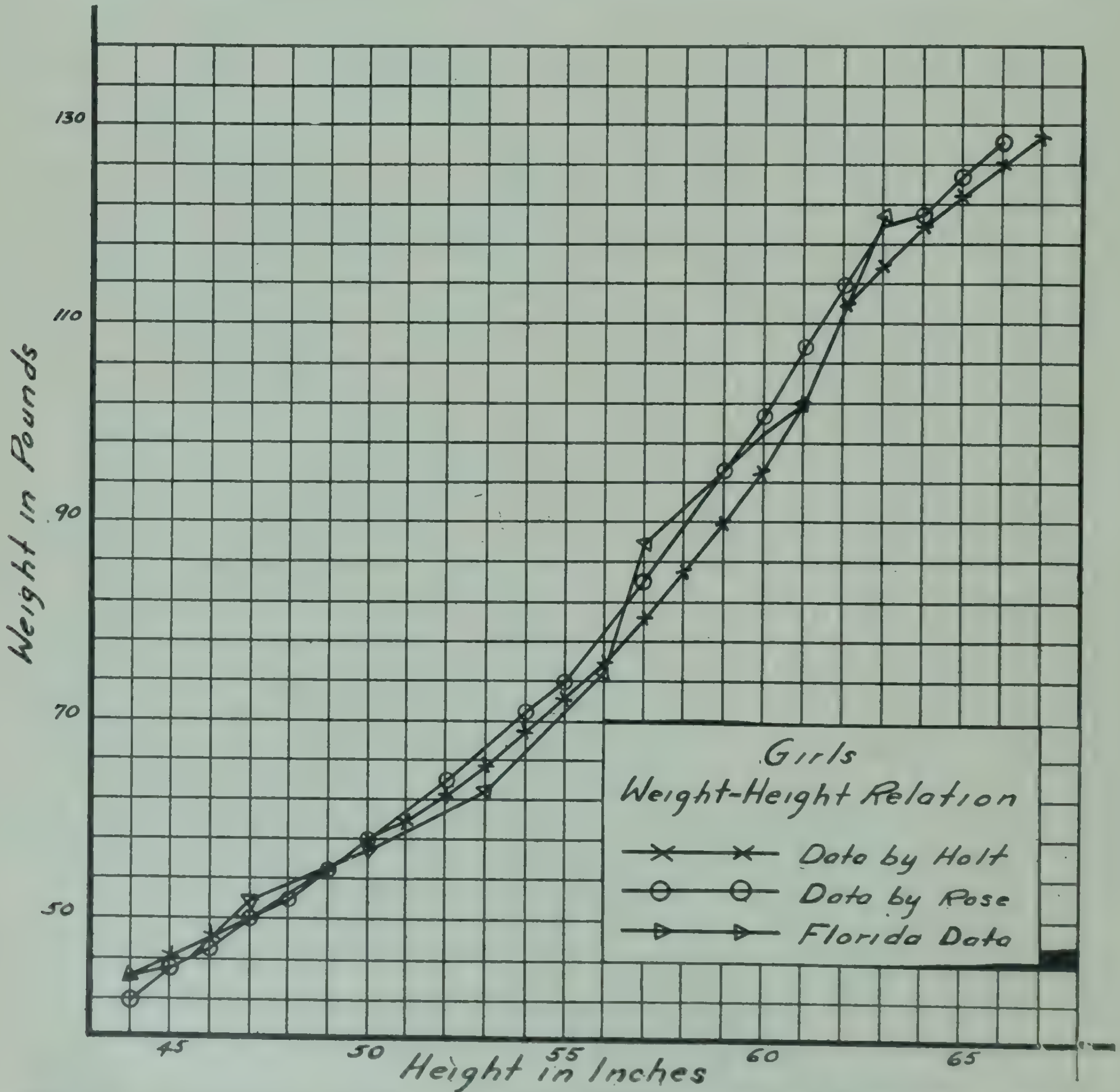

FIG. 6.—Comparison of the average height for weight of Florida girls with standards.

10 and 16. Heart defects were found more frequently above the age of 11 for both boys and girls. Conjunctivitis occurs most frequently between the ages of 6 and 11. Defects of the teeth and gingivitis were found to occur most frequently between the ages of 6 and 12 years. Also defective tonsils and enlarged lymph glands were found to occur most frequently between the ages of 6 and 11. These figures tend to show that defective tonsils, defective teeth and hookworm, which are most common between ages of 6 and 11, are contributing factors to anemia and underweight which are found at ages above 11.

TABLE IV.—AVERAGE RELATION OF WEIGHT TO HEIGHT.

Boys			Girls		
Age years	Height inches	Weight pounds	Age years	Height inches	Weight pounds
6	44	45	6	44	44
7	46	48	7	45	45
8	48	51	8	45.5	46
9	49	55	9	47	52
10	52	60	10	50	57
11	54	67	11	53	63
12	55	72	12	56	75
13	56.5	79	13	57	88
14	58.5	86	14	60	99
15	62	101	15	61	102
16	63	106	16	63	106
17	66	128	17	63	117
18	68	129	18	63	120
19	69	138	19	63	127

MOUTH

Teeth: The most outstanding defect of the mouth was carious teeth. This condition was found more prevalent among the boys, 51.2 percent having carious teeth, than among the girls, with 43.3 percent. As shown by Table V, there is a gradual decrease in the number of children with carious teeth after the twelfth year.

Malocclusions: As stated before, any condition causing an abnormal bite was considered as a malocclusion. This defect showed only a slight variation by sex. Of the boys 14.9 percent had malocclusions, while the percentage of girls with this condition was 11.9.

Gingivitis: The total number of children with this defect was 11.5 percent. Tables VI, VII and VIII show that gingivitis was much more prevalent among the children with defective tonsils, 18.5 percent; with anemia, 20.3 percent, and underweight children, 18.4 percent.

NASOPHARYNGEAL DEFECTS

Defects of the nasopharynx were the most common type of defect noted in this study, occurring in 76.8 percent of all the cases examined.

Tonsils: A singularly even distribution by sex is noted with respect to defective tonsils. The number of children who had tonsils which could be considered normal were about equal to those who showed enlargement or disease.

The percentage of boys with enlarged or diseased tonsils, 52.2 percent, is a little greater than for the girls, 49.3 percent. Of the number with abnormal tonsils, 20.4 percent were found who had tonsils which were considered diseased. In this case also, the boys had a higher percentage than the girls.

Table VI shows a comparison of the defects between children with defective tonsils and the defects of all the children examined.

Anemia and defective hearing show a higher percentage among the children with defective tonsils than the value for all the children, as shown in Table VII. The percent of abnormal tonsils for all the children examined was 49.2 percent, while the percent of abnormal tonsils among the anemic children was 60 percent. Abnormal tonsils are more prevalent among underweight children than among the normal or overweight children, as shown in Table VIII. The incidence of heart defects is also more common among children with defective tonsils.

Adenoids: The percent of children considered as probably having adenoids was 17.6. This was based on the following symptoms which suggested adenoids: (a) mouth breathing; (b) chronic nasal discharge; (c) typical adenoid faces. Adenoids were slightly more prevalent among boys than girls. The number definitely decreased with age, a marked drop being noticeable at the fourteenth year of age.

It is worthy to note the small number of children with adenoids as compared to those with defective tonsils. One explanation of this is that the children of Florida can be out in the fresh air all of the year, and are troubled less with colds than in many other sections of the country.

Nasal Obstruction: Ten percent of the children examined showed nasal obstruction. As with adenoids, this condition was slightly more prevalent among the boys than the girls.

Deflected Septa: Of the total number examined, 12 children had deflected septa. With the exception of one, these were the result of accidents.

SKIN

Of the skin diseases, impetigo, infected sores, dry and yellow skin, were the most common, occurring in about 5 percent respectively for each defect. There was little difference by sex for these defects. As seen by Table V, as age increases the skin defects increase. No apparent relation was shown between impetigo and underweight or anemia as shown by Tables VII and VIII.

The examination for skin defects also included inspection for pediculosis as well. In no case, however, was this condition found.

GLANDS

Superficial Cervical Lymph Glands: The condition of the superficial cervical lymph glands is shown in Table II. These glands were recorded as enlarged when they were easily palpable. The percent of children with this defect was higher among the boys, 42.2, than among the girls, 35.1. It was found that enlargement accompanied, in nearly every case, either carious teeth or enlarged tonsils. As age increases there is a gradual decrease in the percent of children with enlarged glands. At 6 years of age the value is about 40.0 percent, while at 16 years of age the value is 15.0 percent.

THYROID

In this study, 77 children, or 2.3 percent, were found to have thyroid enlargement. This defect predominated in a very large measure among the girls, 68 girls having thyroid enlargement as compared to 9 boys. A study of Table V shows thyroid enlargement to be more prevalent in those children 12 years of age and above. From a study of record forms, it was found that 65 of the 77 children with thyroid enlargement were not native Floridians but came to Florida from the north central states. It will be seen in Table VIII that the incidence of thyroid enlargement is much higher among the underweight children.

HEART

Positive diagnosis of tachycardia or murmur was possible in 423 children, or 12.7 percent of the group. Heart defects were slightly more prevalent among the girls than among the boys, Table II. The incidence of heart defects was more common among the anemic children, those with defective tonsils, and hookworm infested children. Heart defects for children with anemia was found to be 20 percent, for children with defective tonsils 17.5 percent, and for hookworm infested children 18 percent; while for the children who were not anemic, 7 percent had abnormal heart action, children with normal tonsils, 7.9 percent, and for those free from hookworm, 8 percent had heart defects. A sharp rise in the incidence of heart defects comes at about the eleventh year, Table V.

ANEMIA

In addition to the general inspection of the mucous membranes for pallor, a haemoglobinometer was used for determination of an anemic condition. This method gave accurate data not only as to the number with anemia but also as to the degree of anemia. Of this group, 38.6 percent were considered anemic. There was only a very slight difference in this respect between boys and girls. As shown by Table V, the percentages increase with age up to about 13 years.

The percentages for anemia were markedly higher among the children who had hookworm (49 percent), defective tonsils (47 percent), and who were underweight (48 percent), as compared to 38 percent for all children examined. This is shown in Tables I, VI, VIII, and IX.

MALARIA

A surprisingly low figure, 8, was found for children with malaria. These were positively identified by microscopic examination as malaria subjects.

However, this value may be far from representing the true condition, since many of the children from whom the smears were made had taken tonics or quinine, although no history of fever was given.

INTESTINAL PARASITES

Hookworm: Table II shows the percentage of hookworm as found in this survey. The figures show that, of any one defect, hookworm is the most prevalent; 53 percent of the boys and 41 percent of the girls were found, by laboratory methods, to have hookworm infestations.

Table VII shows some of the defects which are more prevalent among children with hookworm, these being anemia, heart defects and gingivitis.

Table V shows that the time of heaviest infestation is between the ages of 8 and 12 years.

Ascaries and Tapeworm: Comparatively few children, 17, were found to be infested with ascaries and only 11 were found to have tapeworm.

Age and Sex		No Defects		Underweight		Overweight		Anemic		Hookworm		Enl. Tonsils		Adenoids		Hearing		Thyroid	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Both Sexes Age in Years	6	13	3.2	93	23.2	29	7.1	151	37.4	181	45.1	219	54.7	59	14.8	24	5.9	..	...
	7	12	3.6	66	20.0	23	7.0	130	39.5	170	51.7	174	52.9	68	20.7	15	4.6	..	...
	8	14	4.5	77	23.7	22	6.7	115	35.8	167	52.0	171	53.2	59	18.3	21	6.4	2	0.6
	9	14	4.4	87	27.6	38	11.6	107	34.6	169	54.1	157	50.3	43	13.8	28	8.6	1	0.3
	10	14	4.3	83	27.0	33	10.2	134	43.4	184	56.8	183	56.5	64	19.7	20	6.2	3	0.9
	11	9	3.0	91	30.7	38	12.7	116	39.7	160	54.3	159	54.0	55	18.7	19	6.3	5	1.7
	12	11	4.5	87	37.7	31	12.7	88	36.1	103	42.2	118	48.4	38	15.6	18	7.4	6	2.5
	13	12	5.0	80	35.7	30	12.4	101	43.2	104	44.3	89	37.8	35	14.9	23	9.5	16	6.6
	14	10	5.1	70	36.3	28	14.3	77	39.3	90	45.9	83	42.3	19	9.7	23	11.7	7	3.6
	15	13	8.0	46	27.7	31	18.4	68	40.5	68	40.5	80	47.6	12	7.1	14	8.3	14	8.3
	16	15	9.8	41	28.3	21	13.7	45	29.4	61	39.9	48	31.4	9	5.9	16	10.5	2	1.3
	17	8	8.3	27	28.5	13	14.0	26	28.6	30	32.6	41	43.2	3	3.2	5	5.3	7	7.4
	18	5	7.3	13	18.6	9	12.0	17	25.0	21	30.9	22	32.2	..	...	3	4.4	4	5.9
	19	5	8.2	6	11.1	6	10.7	9	14.7	6	11.5	14	25.0	..	...	3	4.9	2	3.3
Boys	6	9	4.4	43	20.8	11	5.3	78	37.9	101	49.2	115	55.8	36	17.5	17	8.2	..	...
	7	4	2.6	32	20.5	8	5.1	58	37.2	87	55.8	97	62.1	33	21.2	10	6.4	..	...
	8	6	3.8	34	22.3	7	4.6	58	38.1	100	65.7	82	54.6	33	21.7	10	6.6	..	...
	9	3	2.8	28	22.4	22	16.7	49	37.1	80	60.6	68	50.0	20	15.1	9	6.8	..	...
	10	6	3.1	35	23.0	14	8.5	68	41.5	103	62.8	97	52.4	30	18.3	10	6.1	1	0.6
	11	4	2.9	40	29.1	13	9.5	54	39.4	81	59.1	76	55.4	26	19.0	11	8.0	1	0.7
	12	4	3.4	38	35.0	11	9.5	45	38.8	57	49.1	66	48.1	26	22.4	11	9.5	..	...
	13	5	4.8	36	38.1	12	11.5	49	47.1	57	54.8	44	42.3	18	17.5	15	14.4	2	1.9
	14	4	4.2	36	40.1	7	7.4	38	40.4	45	47.9	37	39.4	11	11.7	14	14.9	..	...
	15	5	6.7	22	30.0	8	10.8	35	47.3	36	48.8	41	55.4	6	8.1	7	9.5	2	2.7
	16	7	10.1	23	35.2	8	11.6	19	27.5	32	46.4	22	31.9	7	10.1	10	14.5	..	...
	17	3	8.3	9	25.0	3	8.4	8	22.2	12	33.3	14	40.4	1	2.8	3	8.3	..	...
	18	2	6.9	5	16.6	1	3.4	8	27.6	13	44.8	8	27.6	..	...	2	6.9	..	...
	19	4	17.4	3	13.0	3	13.0	3	13.0	5	21.7	7	30.4	..	...	3	13.0	..	...
Girls	6	4	1.9	50	25.6	15	7.5	73	36.8	80	41.0	104	53.5	23	12.0	7	3.5	..	...
	7	8	4.6	34	22.0	15	8.7	72	41.6	83	48.0	77	44.5	35	20.2	5	2.9	..	...
	8	8	4.7	43	25.2	13	7.4	57	33.5	67	39.4	89	52.3	26	15.4	11	6.3	2	1.1
	9	11	6.1	59	32.8	15	7.7	58	32.2	89	49.4	90	50.0	23	12.8	19	9.7	1	0.5
	10	8	5.0	48	31.6	19	11.9	66	41.2	81	50.6	86	60.6	34	21.3	10	6.3	2	1.9
	11	5	3.1	51	32.2	22	13.5	62	40.0	79	50.0	83	52.5	29	18.4	8	4.9	4	2.5
	12	7	5.5	49	40.4	21	16.4	43	33.6	46	35.9	52	40.6	12	9.4	7	5.5	6	4.7
	13	7	5.1	44	33.3	21	15.3	52	39.3	47	35.6	45	34.5	17	13.1	8	5.8	14	10.2
	14	6	5.9	34	32.6	21	20.6	39	38.2	45	44.1	46	45.1	8	7.8	9	8.8	8	7.8
	15	8	8.5	24	25.5	23	24.5	33	35.1	32	34.0	39	41.5	6	6.4	7	7.4	12	12.8
	16	8	9.1	18	21.4	13	15.5	26	30.9	29	34.5	26	30.9	2	2.4	2	2.4	2	2.4
	17	5	7.1	18	32.0	10	17.5	20	35.0	18	31.5	23	40.4	2	3.4	2	3.4	7	11.9
	18	3	7.7	8	20.6	8	20.5	9	23.1	8	20.5	14	35.9	..	...	1	2.6	4	10.3
	19	1	3.3	3	9.1	3	9.0	6	18.1	2	6.0	6	18.4	..	...	..	...	2	5.3

TABLE V.—DEFECTS AND AGE—Continued.

Age and Sex		Heart No.	Heart %	Vision No.	Vision %	Conjunctivitis No.	Conjunctivitis %	Teeth No.	Teeth %	Gingivitis No.	Gingivitis %	Skin No.	Skin %	Enl. Glands No.	Enl. Glands %	Posture No.	Posture %	Total No. Children
Both Sexes Age in Years	6	28	7.1	68	16.9	157	39.1	200	49.3	55	13.7	105	26.1	175	43.6	34	8.5	401
	7	22	7.3	71	20.9	120	36.5	159	54.4	40	12.1	76	23.1	124	37.7	33	10.0	329
	8	24	7.3	94	29.1	97	30.0	179	56.5	38	11.8	71	22.0	106	32.9	48	14.9	322
	9	25	8.0	94	30.0	125	40.0	172	55.2	31	9.9	78	25.0	115	36.8	43	13.7	312
	10	46	14.2	111	34.3	94	29.0	162	50.1	49	15.1	88	27.1	130	40.1	39	12.0	324
	11	33	11.2	83	28.3	90	30.6	135	46.3	31	10.5	79	26.9	93	31.5	38	13.2	295
	12	35	14.3	76	31.1	90	36.8	107	45.5	22	9.0	61	25.0	85	34.8	23	9.4	244
	13	31	13.1	73	31.1	51	21.6	92	39.0	27	11.7	53	22.4	63	26.7	23	9.7	236
	14	30	15.3	69	35.2	36	18.4	61	34.2	22	11.2	46	23.4	58	29.6	16	8.2	196
	15	26	15.5	33	19.6	34	20.2	50	29.8	13	7.7	42	25.0	65	38.7	15	8.9	168
	16	21	13.7	45	29.4	30	19.6	42	27.4	12	7.8	25	16.3	27	17.6	9	5.9	153
	17	13	13.7	13	13.7	22	23.6	23	24.8	4	4.3	15	16.1	13	14.0	7	7.5	93
	18	11	16.3	10	14.7	15	22.0	18	26.5	3	4.4	8	11.8	12	17.6	6	8.8	68
	19	5	8.2	6	9.6	7	12.5	15	25.0	2	3.5	5	10.7	13	23.2	4	7.1	56
Boys	6	12	5.8	25	12.1	80	38.3	114	55.3	30	14.6	57	27.6	92	44.7	21	10.2	206
	7	66	3.8	35	22.4	60	38.5	86	55.1	20	12.9	36	23.1	57	36.5	17	10.9	156
	8	9	5.9	48	31.6	50	32.8	97	63.8	18	11.8	38	25.0	66	43.4	30	19.7	152
	9	10	7.6	46	34.8	65	49.2	80	60.6	15	11.4	41	31.1	53	40.2	19	14.4	132
	10	21	12.8	68	41.5	48	29.2	96	58.5	21	13.0	44	26.8	71	43.3	20	12.2	164
	11	12	8.8	47	34.3	46	33.5	71	51.8	16	11.6	39	28.5	47	34.3	23	16.8	137
	12	14	12.1	37	31.9	48	41.3	52	44.8	9	7.7	31	26.7	38	32.7	16	13.8	116
	13	11	10.6	42	40.4	26	25.0	43	41.3	14	13.8	29	27.9	31	29.8	9	8.6	104
	14	11	11.7	39	41.5	19	20.2	36	38.3	15	16.1	26	27.7	39	41.5	6	6.4	94
	15	11	14.9	20	27.0	17	23.0	27	36.4	7	9.4	22	29.7	30	40.5	8	10.8	74
	16	9	13.0	20	29.0	17	24.5	21	30.4	7	10.1	13	19.0	17	24.6	4	5.8	69
	17	4	11.1	5	13.9	9	25.0	9	25.0	2	5.6	7	19.4	4	11.1	..	...	36
	18	1	3.4	4	13.8	8	27.6	11	37.9	1	3.4	4	14.1	4	14.1	3	10.3	29
	19	2	8.7	2	8.7	3	8.7	6	26.0	1	4.6	3	13.0	4	17.4	..	...	23
Girls	6	16	8.0	43	22.0	77	39.6	86	44.1	25	12.8	48	24.6	83	42.5	13	6.6	195
	7	16	9.2	36	21.8	60	34.6	73	42.2	20	11.6	40	23.1	67	38.7	16	10.4	173
	8	15	8.6	46	26.0	47	27.7	82	48.2	20	11.7	33	19.4	40	23.5	18	10.5	170
	9	15	7.7	48	24.6	60	33.3	92	51.1	16	8.8	37	20.5	62	34.4	24	13.3	180
	10	25	15.6	43	26.9	46	28.7	66	41.2	28	17.5	44	27.5	59	36.9	19	11.9	160
	11	21	12.9	36	22.3	44	27.8	64	40.5	15	9.4	40	25.3	46	29.1	15	9.4	158
	12	21	16.4	39	30.5	42	32.8	55	42.9	13	10.1	30	23.4	47	36.7	7	5.5	128
	13	20	14.6	31	23.8	25	19.0	49	37.1	13	9.8	24	18.1	32	24.2	14	10.6	132
	14	19	18.6	30	29.4	17	16.5	25	24.5	7	6.8	20	19.2	19	18.6	10	9.8	102
	15	15	16.0	13	13.8	17	18.0	23	24.4	6	6.3	20	21.2	35	37.2	7	7.4	94
	16	12	14.3	25	29.8	13	15.4	21	25.0	5	5.9	12	14.2	10	11.9	5	5.9	84
	17	9	15.3	8	14.0	13	22.8	14	24.5	2	3.5	8	14.0	9	15.8	7	12.3	57
	18	10	25.6	6	15.4	7	18.0	7	18.0	2	5.1	4	10.2	8	20.5	3	7.7	39
								9	27.2	1	3.3	2	6.0	9	27.2	4	12.1	33

INCIDENCE OF DEFECTS WITH CERTAIN SPECIFIC DEFECTS

An effort was made to determine whether the incidence of certain defects was greater among some specific defects than among other defects. In order to do this, four defects—anemia, underweight, defective tonsils and hookworm infestation—were chosen as the specific defects. Four tables were made, one for each of the above-mentioned defects, and the defects accompanying the specific defect were tabulated. In this way the frequency with which other defects occurred among children having one or more of the specific defects could be compared to the frequency with which they occurred for the whole group; also the frequency with which other defects occurred among children free from the above-mentioned specific defects. Tables VI, VII, VIII and IX point out some interesting relations.

PREVALENCE OF DEFECTS AMONG CHILDREN WITH ENLARGED TONSILS

In Table VI are tabulated some of the defects which were found among children with enlarged tonsils. A comparison of the frequency with which these same defects occur for the whole can be made. Those defects which show a decided increase among the children with enlarged tonsils are: anemia, defective hearing, defective teeth, gingivitis, and heart defects. Of these, anemia and heart defects are the most outstanding; 47.2 percent of the children with defective tonsils being anemic, while 30 percent of the children with tonsils not defective were anemic; and 17.5 percent of the children with defective tonsils had heart defects, while 8.8 percent of the children with normal tonsils had heart defects. Defective hearing also was found to be quite prevalent among the children with defective tonsils, 9.5 percent, while for children with normal tonsils, 5.4 percent had defects of hearing. Gingivitis and teeth defects also show an appreciable difference for the two groups.

PREVALENCE OF DEFECTS AMONG ANEMIC CHILDREN

Table VII shows a comparison of the defects common to anemic children with the defects of the whole group of children examined. Of the anemic children, 57.3 percent have hookworm, while 40.6 percent of these not anemic have hookworm. Defective tonsils are more common among anemic children, 60.2 percent, as compared to 52.3 percent for children not anemic. Conjunctivitis, gingivitis and carious teeth are other defects which are more

TABLE VI.—DEFECTS OF CHILDREN WITH DEFECTIVE TONSILS COMPARED WITH DEFECTS OF ALL CHILDREN EXAMINED.

Defects	All Children Examined						Children with Defective Tonsils					
	Both Sexes		Boys		Girls		Both Sexes		Boys		Girls	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total No. Examined	3,325	...	1,577	...	1,748	...						
Total No. Weighed	3,027	...	1,415	...	1,612	...						
Tonsils	1,637	49.2	824	52.2	813	46.5	1,637	...	824	...	813	...
Hookworm	1,565	47.1	845	53.6	720	43.7	776	47.4	428	51.9	348	42.8
Anemia	1,282	38.6	630	39.9	652	37.3	773	47.2	403	48.9	370	45.5
Overweight	380	12.5	140	9.9	240	14.9	139	8.5	49	5.9	90	11.1
Underweight	977	32.3	431	30.5	546	33.9	572	34.9	256	30.9	316	38.8
Vision	886	27.5	452	28.7	434	26.3	464	28.2	209	25.4	253	31.1
Conjunctivitis	1,012	30.4	512	32.5	500	30.3	386	23.6	195	23.7	191	23.5
Hearing	247	7.4	146	9.3	101	6.1	156	9.5	86	10.4	70	8.6
Gingivitis	384	11.9	182	11.5	202	12.3	271	16.5	132	16.0	139	17.1
Teeth	1,520	45.7	807	51.2	713	43.3	886	54.1	485	58.9	401	49.3
Impetigo	167	5.0	88	5.6	57	3.5	83	5.1	47	5.7	36	4.4
Heart	423	12.7	181	11.5	242	14.7	288	17.5	157	19.0	131	16.1
Thyroid	77	2.3	9	.6	68	4.1	35	2.1	2	.2	33	4.1

TABLE VII.—DEFECTS OF ANEMIC CHILDREN COMPARED WITH ALL CHILDREN EXAMINED.

Defects	All Children Examined						Children with Anemia					
	Both Sexes		Boys		Girls		Both Sexes		Boys		Girls	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total No. Examined	3,325	...	1,577	...	1,748	...						
Total No. Weighed	3,027	...	1,415	...	1,612	...						
Anemic	1,282	38.6	630	39.9	652	37.3	1,282	100.0	630	100.0	652	100.0
Hookworm	1,565	47.1	845	53.6	720	41.2	735	57.3	402	63.8	333	51.1
Tonsils	1,637	49.2	824	52.2	813	46.5	772	60.2	410	65.1	362	55.5
Overweight	380	12.3	140	9.9	240	14.9	137	10.7	68	10.8	69	10.6
Underweight	977	32.3	431	30.5	546	33.9	437	34.1	209	33.2	228	35.0
Vision	886	26.6	452	28.7	434	29.8	391	30.5	181	28.7	210	33.2
Conjunctivitis	1,012	30.4	512	32.5	500	28.6	512	39.9	261	41.4	251	38.5
Hearing	423	12.7	181	11.5	242	13.8	97	15.4	56	8.9	41	6.3
Teeth	1,520	45.7	807	51.2	713	40.8	721	56.2	396	62.9	325	49.8
Gingivitis	384	11.5	182	11.5	202	11.6	260	20.3	126	20.0	134	20.5
Impetigo	167	5.0	88	5.6	79	4.5	83	6.5	47	7.5	36	5.5
Heart	423	12.7	181	11.5	242	13.8	264	20.6	117	18.6	147	22.5
Thyroid	77	2.3	9	.6	68	3.9	41	3.2	4	.6	37	5.7

TABLE VIII.—DEFECTS OF UNDERWEIGHT CHILDREN COMPARED WITH ALL CHILDREN EXAMINED.

Defects	All Children Examined						Underweight Children					
	Both Sexes		Boys		Girls		Both Sexes		Boys		Girls	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total No. Examined	3,325	...	1,577	...	1,748	...						
Total No. Weighed	3,027	...	1,415	...	1,612	...						
Underweight	977	32.3	431	30.5	546	33.9	977	100.0	431	100.0	546	100.0
Hookworm	1,565	47.1	845	53.6	720	41.2	475	48.6	241	53.9	234	42.8
Anemia	1,282	38.6	630	39.9	652	37.3	475	48.6	230	53.4	245	44.9
Tonsils	1,637	49.2	824	52.2	813	46.5	572	58.5	256	59.4	316	57.8
Vision	886	26.6	452	28.7	434	29.8	300	30.7	120	27.8	180	53.0
Conjuctivitis	1,012	30.4	512	32.5	500	28.6	395	40.4	199	46.2	196	35.9
Hearing	247	7.4	146	9.3	101	5.8	78	8.0	39	9.0	39	7.1
Teeth	1,520	45.7	807	57.2	713	40.8	545	55.8	266	61.7	279	51.1
Gingivitis	394	11.5	182	14.9	202	11.6	181	18.5	84	19.5	97	17.8
Impetigo	167	5.0	88	5.6	79	4.5	64	6.6	39	9.0	25	4.6
Heart	423	12.7	181	11.5	242	13.8	151	15.5	62	14.4	89	16.3
Thyroid	77	2.3	9	.6	68	3.9	54	5.5	8	1.8	46	8.4

TABLE IX.—DEFECTS OF CHILDREN WITH HOOKWORM COMPARED WITH ALL CHILDREN EXAMINED.

Defects	All Children Examined						Children with Hookworm					
	Both Sexes		Boys		Girls		Both Sexes		Boys		Girls	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total No. Examined	3,325	...	1,577	...	1,748	...						
Total No. Weighed	3,027	...	1,415	...	1,612	...						
Hookworm	1,565	47.1	845	53.6	720	41.2	1,565	100.0	845	100.0	720	100.0
Tonsils	1,637	49.2	824	52.2	813	46.5	760	45.1	387	45.8	319	44.3
Anemia	1,282	38.6	630	39.9	652	37.3	776	49.6	389	46.0	387	53.8
Overweight	380	12.3	140	9.9	240	14.9	272	17.3	112	13.2	160	23.8
Underweight	977	32.3	431	30.5	546	33.9	347	22.2	183	21.7	164	22.8
Vision	886	26.6	452	28.7	434	29.8	326	20.8	160	18.9	166	23.0
Conjunctivitis	1,020	30.4	512	32.5	500	28.6	538	34.4	278	32.9	260	36.1
Hearing	423	12.7	181	11.5	242	13.8	81	5.2	51	6.0	30	4.2
Teeth	1,520	45.7	807	51.2	713	40.8	837	53.5	487	57.6	350	48.6
Gingivitis	384	11.5	182	11.5	202	11.6	262	16.7	137	16.2	125	17.4
Impetigo	167	5.0	88	5.6	79	4.5	63	4.0	39	4.6	24	3.3
Heart	423	12.7	181	11.5	242	13.8	282	18.0	132	15.6	150	20.8
Thyroid	77	2.3	9	.6	68	3.9	24	1.5	4	.5	20	2.8

prevalent among anemic children. Heart defects were found to be almost three times as high among anemic children as among the children not anemic. Only a slight difference was found for the percent of underweight among anemic children, 34 percent, and children not anemic, 30 percent. Anemia is usually considered a fairly constant sign of malnutrition; however, these figures do not justify the statement that underweight is definitely associated with anemia.

PREVALENCE OF DEFECTS AMONG UNDERWEIGHT CHILDREN

In Table VIII are given some of the relationships of defects among underweight children and the whole group of children examined. As shown by Table VII, anemia is not necessarily accompanied by underweight. However, Table VIII shows that anemia is more prevalent among underweight children: 39.3 percent of the children who were not underweight were anemic, while 48 percent of the underweight children were anemic. These data show that anemia is more common among the underweight children but, on the other hand, they do not permit the conclusion that underweight is common among anemic children.

PREVALENCE OF DEFECTS AMONG CHILDREN WITH HOOKWORM

Table IX shows that anemia is more common among hookworm children than among children free from hookworm. Defective teeth and gingivitis occur most frequently among hookworm children. Heart defects were found prevalent among hookworm subjects, paralleling heart defects among anemic children and children with defective tonsils. Overweight was more prevalent among the hookworm group than in any other group. One possible explanation of this is that children heavily infested with hookworm fail to make the average growth in height while at the same time edema and a distended abdomen develop. This added weight, with a shorter stature, causes overweight, Table IX.

RELATIONS OF SPECIFIC DEFECTS

A study of Tables VI, VII, VIII and IX points out some factors which contribute to pallor, malnutrition and abnormal weight relations. Defective tonsils, defective teeth, thyroid disturbances and hookworm infestation are some of the causative factors. In interpreting these relations, it must be kept in mind that other factors are involved and that parallelism does not necessarily prove cause and effect relations. It is not the intent here to give the impression that the above-mentioned defects are the only factors in causing a condition resembling malnutrition and abnormal weight relations.

These tables also show a very marked association of defective tonsils, hookworm infestation and anemia, with heart defects. The Public Health Reports (*6*) show that in the period 1921-1927, 20 out of every 100,000 children from 5 to 19 years of age died of heart disease annually in the registration area. Practically 75 percent of all cases of heart disease develop in children under 10 years of age. Special reports obtained by the United States Public Health Service for 1928 from certain states with an aggregate population of 25 million, showed that 228 persons out of every 100,000 died from heart disease as compared with 106 from kidney disease, 105 from cancer and 100 from pneumonia, the four great killers of mankind.

Tabulations of physical records of approximately 5,000 school children under Public Health Service supervision showed that 40 out of every 1,000 children with defective tonsils had heart disease, while, of the children who had normal tonsils, 9 out of every 1,000 had heart disease.

It should be noted that in this survey not only defective tonsils but also hookworm infestation are associated with heart defects, and that the incidence of heart defects is higher in this group than is reported in tabulations by the United States Public Health Service. This is a grave situation! From the standpoint of health promotion it is unfortunate that people are more impressed by new and startling events regarding diseases than by more serious conditions which develop slowly. Few people realize the growing menace to life of heart disease and that its importance as a public health problem is greater than that of tuberculosis or cancer.

DIETS

The diets of 2,110 children were studied and scored by the methods previously described. The principal items in the menus for the entire day appear in Table X and are given in Fig. 7. The scores for the diets for the entire day are shown in Table X and also appear in Fig. 8.

It should be borne in mind that the commendable diet, represented by a score of 85 or above, is one that is capable of meeting the body's needs and is not one difficult of attainment. Further, such a diet need not be an expensive one—dairy products, cereal, vegetables, fruit, an egg or meat daily being sufficient to allow a diet to qualify in this group. This being the case, one would ex-

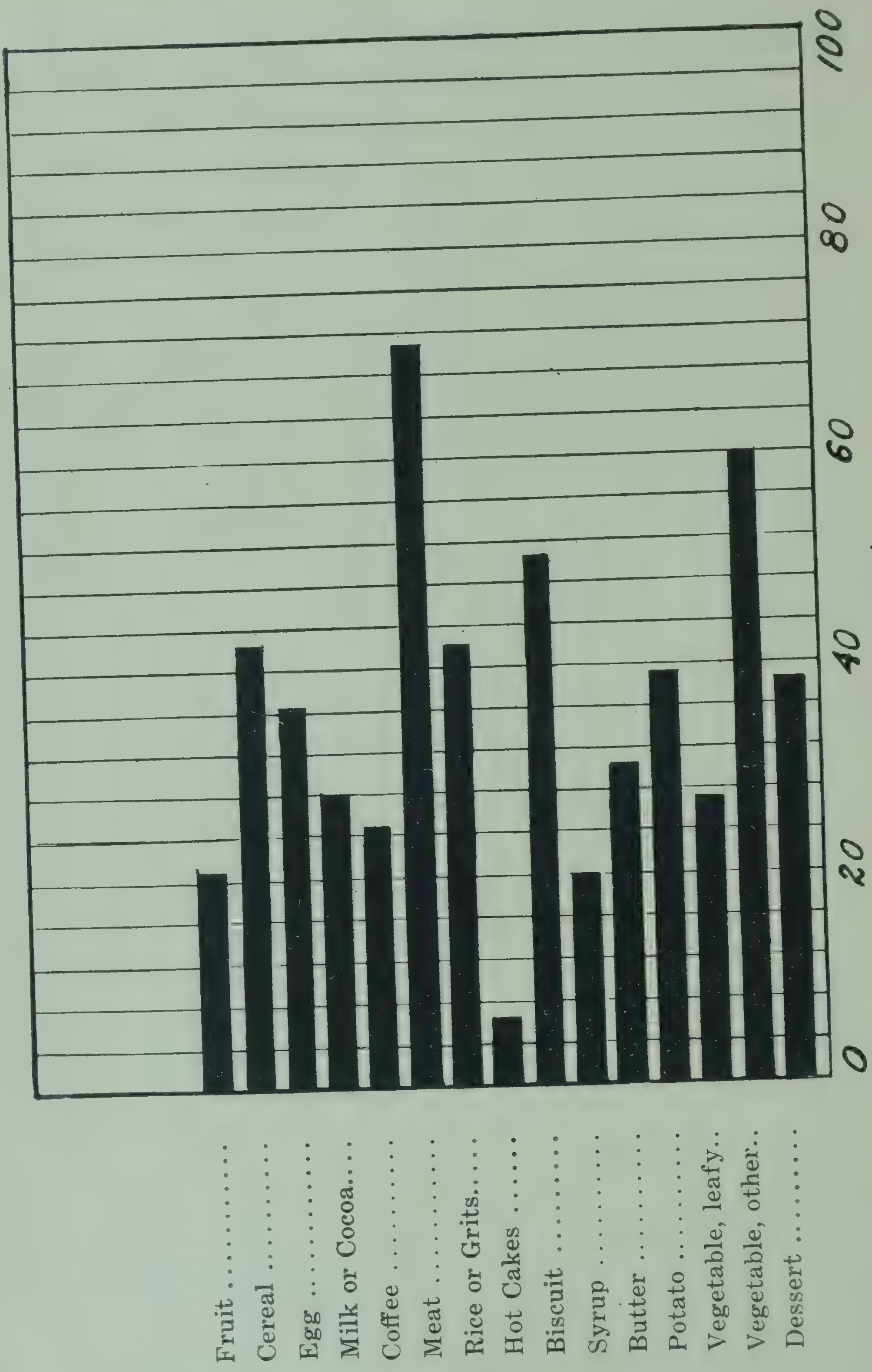

FIG. 7.—Frequency with which the most usual foods appear in the menus for the entire day.

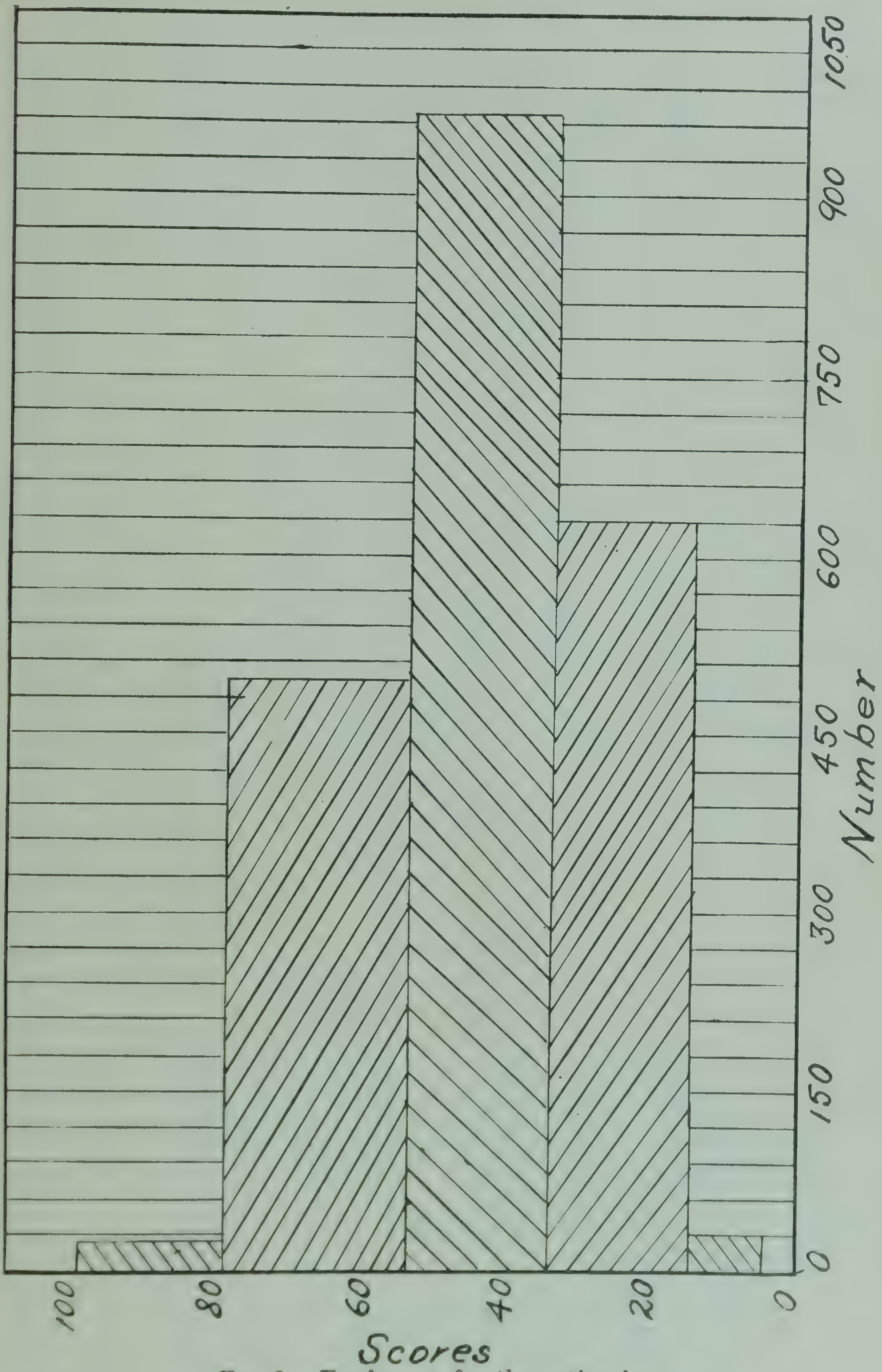

FIG. 8.—Food score for the entire day.

pect a large majority of the children to fall into this group. However, only 1.2 percent of the children could qualify. Likewise the number in the adequate group, 60-80, was small, amounting to only 23.4 percent. Almost twice this number, 45.7 percent, had diets which were highly questionable, this group being represented by the numerical values 40-55. Almost one-third, or 29.9 percent, of the children had diets which were plainly incapable of meeting the bodily requirements; of this group 1.4 percent had diets which were classed as distinctly deficient.

In Table X and also in Fig. 7 are shown the frequency with which certain foods occur in the menus for the entire day. Meat heads the list; 69.6 percent of the menus included meat. Vegetables other than leafy or potatoes were next, occurring in 59.9 percent of the menus. Another item to occur in more than 50 percent of the menus was biscuit. The items which were found so frequently are foods that are low in value on scoring.

Another group of foods occurring quite frequently and also low in scoring value includes: cereal, rice or grits, potato and dessert. Foods with high values on the score sheet occur less frequently. These include fruit, found in 20.9 percent of the menus; milk, found in 28.4 percent of the menus; and leafy vegetables, found in 27.0 percent of the menus.

TABLE X.—FREQUENCY WITH WHICH CERTAIN FOODS OCCUR IN THE MENUS FOR THE ENTIRE DAY.

Food	Number	Percent
Fruit	442	20.9
Cereal	884	41.8
Egg	759	35.9
Milk or Cocoa	600	28.4
Coffee	520	24.6
Meat	1,470	69.6
Rice or Grits	878	41.6
Hot Cakes	135	6.3
Biscuit	1,076	50.9
Syrup	412	19.5
Butter	642	30.4
Potato	801	38.0
Vegetable, leafy	568	27.0
Vegetable, other	1,266	59.9
Dessert	801	38.0
Total Number of Menus	2,110	

TABLE X-a.—SCORE OF MENUS FOR THE ENTIRE DAY.

Scores	Number	Percent
5- 15	30	1.4
20- 35	601	28.5
40- 55	963	45.7
60- 80	493	23.4
85-100	23	1.1

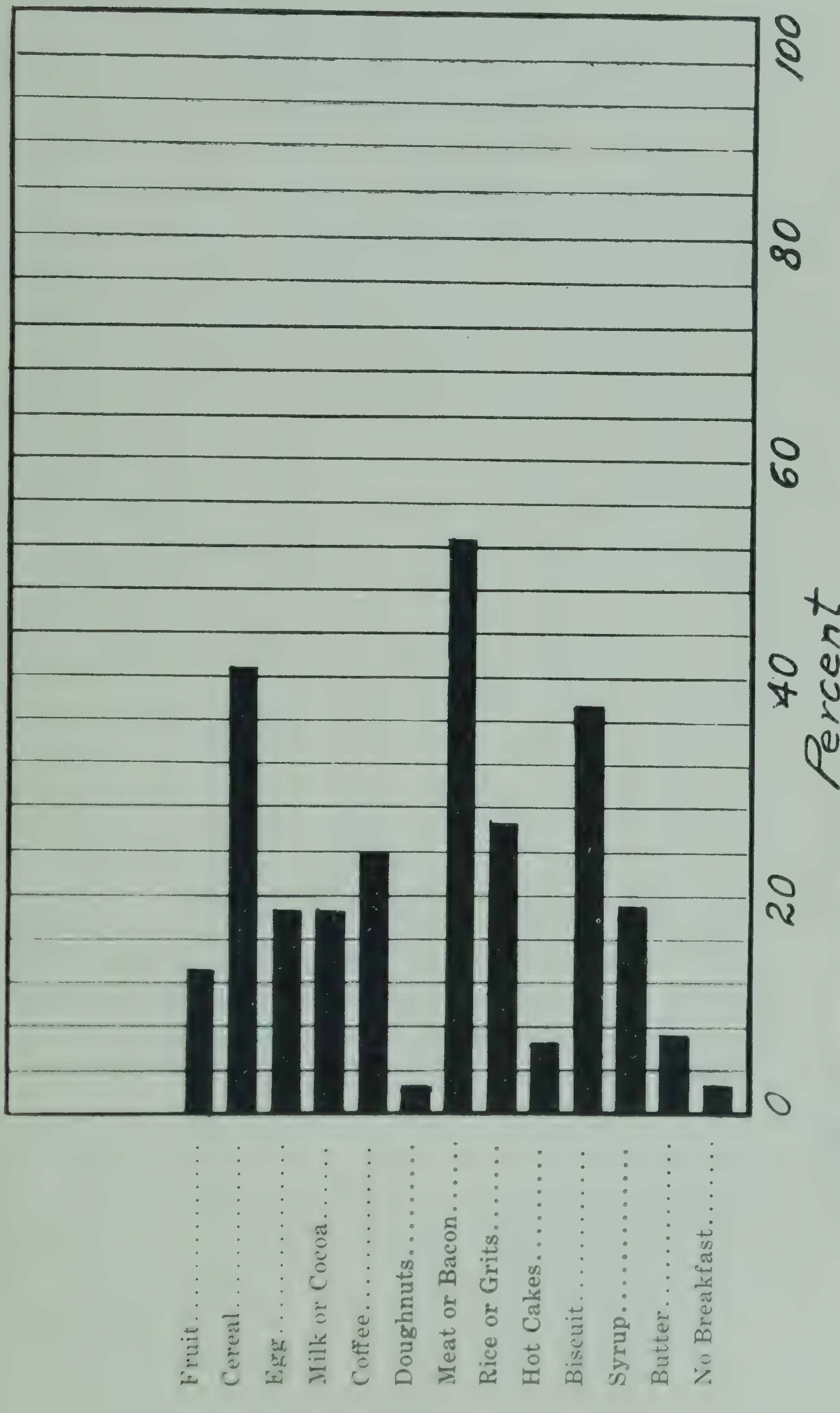

FIG. 9.—Frequency with which the principal items appear in the breakfast menus.

MENUS

A study was made of the menus for the different meals throughout the day. Tables X, XI, XII and XIII and Figs. 7, 8, 9, 10 and 11 show in a large majority of cases that no attempt was made to provide foods particularly suited for growing children.

BREAKFAST

An analysis of the menus for breakfast, given in Table XI, shows that biscuit, cereal and meat* were the foods most frequently eaten at breakfast. A little over a third of the children had cereal and milk, 18.5 percent had eggs, but only 13.0 percent had fruit. Coffee and tea were used in 23.9 percent of the menus. Fig. 9 and Table XI show the principal items appearing in the menus for breakfast.

Table XI-a shows the scores for the breakfasts. By reference to Table I a value of 40 will be found as the score required for an adequate breakfast. A score of 25 to 35 represents the numerical values for questionable breakfasts and anything below 25 is inadequate. Over 50 percent of the children had inadequate breakfasts, about 40 percent had questionable breakfasts, and about 10 percent had adequate breakfasts. Of all the children, 45 had no breakfast on the two days the menus were collected and 111 had breakfast consisting of biscuit and butter.

TABLE XI.—FREQUENCY WITH WHICH CERTAIN FOODS OCCUR IN BREAKFAST MENUS.

Food	Number	Percent
Fruit	276	13.0
Cereal	856	40.5
Egg	391	18.5
Milk or Cocoa	600	28.5
Coffee	505	23.9
Doughnuts	51	2.4
Meat or Bacon	1,113	52.7
Rice or Grits	562	26.6
Hot Cakes	136	6.4
Biscuit	789	37.3
Syrup	399	18.9
Butter	149	7.0
No Breakfast	46	2.1
Total Number of Breakfasts	2,110	

TABLE XI-a.—BREAKFAST SCORES.

Scores	Number	Percent
No Breakfast	46	2.1
5-20	1,193	56.5
25-35	671	31.2
40 and Over	202	9.5
Total Number of Breakfasts	2,110	

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*The term meat includes bacon.

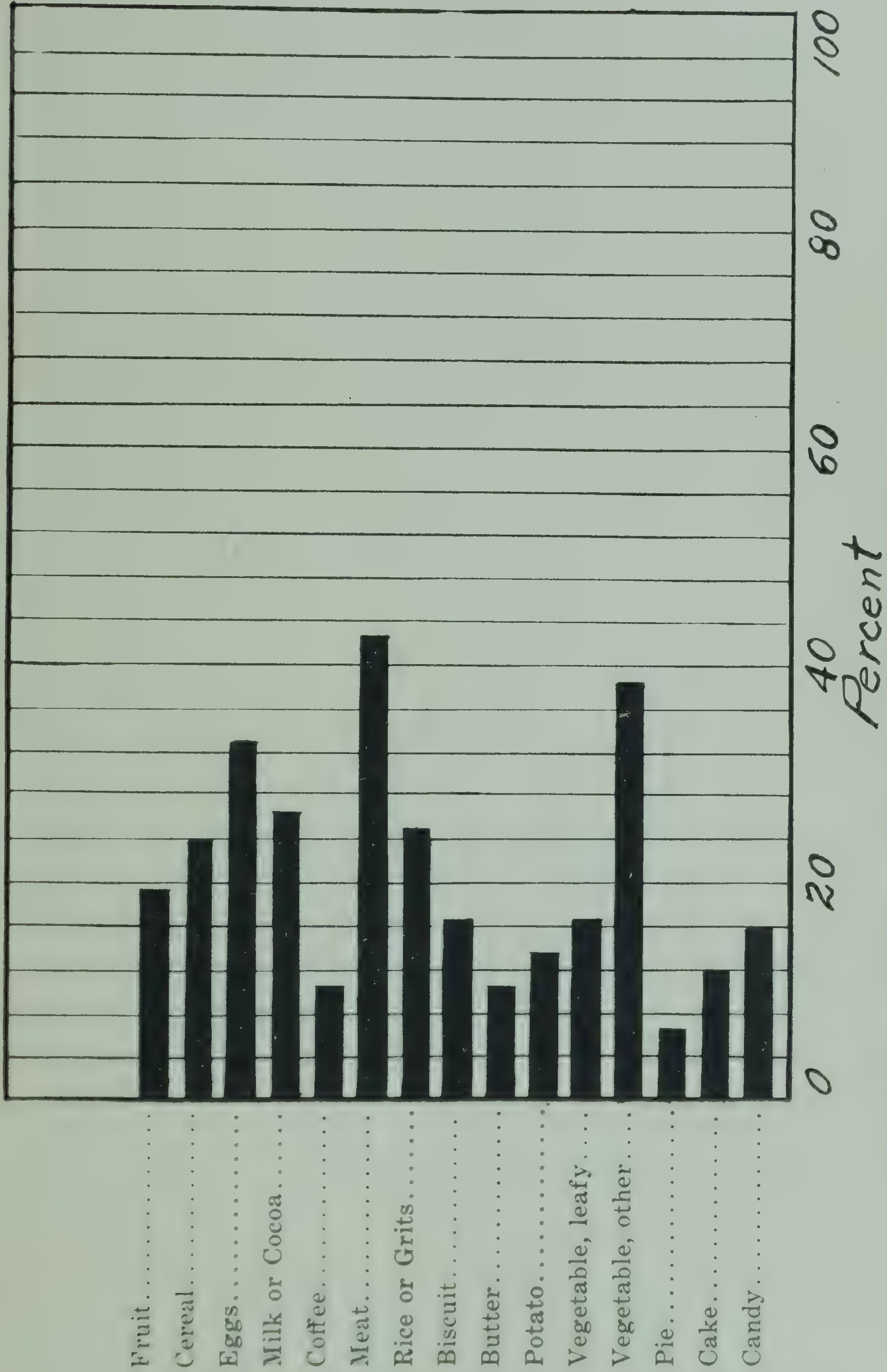

FIG. 10.—Frequency with which the principal items appear in lunch menus.

LUNCH

Of the principal items occurring as shown by Table XII and Fig. 10, in the lunch menus, eggs (32.7 percent), meat (42.8 percent), vegetables other than potatoes or leafy vegetables (38.7 percent), were found most often. Rice and grits (25.1 percent) and milk (26.1 percent) came next. Fruit (19 percent) was low, especially for lunch menus.

In Table XII-a are given the scores for lunch. As many as 48 percent of the children fell into the group with a score of 25 or less, representing an inadequate lunch. Thirty-nine percent of the menus had a score of 30-45, or were menus of which the adequacy was questionable. Thirteen percent of the children were in the group with a score of 50 or above, indicating that they had an adequate lunch.

TABLE XII.—FREQUENCY WITH WHICH CERTAIN FOODS OCCUR IN THE LUNCH MENUS.

Food	Number	Percent
Fruit	409	19.0
Cereal	496	23.5
Eggs	691	32.7
Milk or Cocoa	435	26.1
Coffee	221	10.4
Meat	903	42.8
Rice or Grits	530	25.1
Biscuit	350	16.5
Butter	218	9.8
Potato	288	13.6
Vegetable (leafy)	351	16.6
Vegetable (other)	817	38.7
Pie	132	6.2
Cake	252	11.8
Candy	334	15.6
Total Number of Lunches	2,110	

TABLE XII-a.—LUNCH SCORES.

Scores	Number	Percent
No Lunch	55	2.6
5-25	957	45.7
30-45	823	39.0
50 and Over	275	13.0
Total Number of Lunches	2,110	

DINNER

The chief items of the dinners are given in Table XIII and in Fig. 11. Vegetables other than leafy or potatoes head the list. Meat was found to be the next most prevalent item of the dinner menus. Rice and grits, potatoes, butter, cereal and milk were found in nearly one-third of the menus, while fruit, 18.5 percent, and leafy vegetables, 21.6 percent, were surprisingly low.

By reference to Table XIII-a it will be seen that over 53 percent

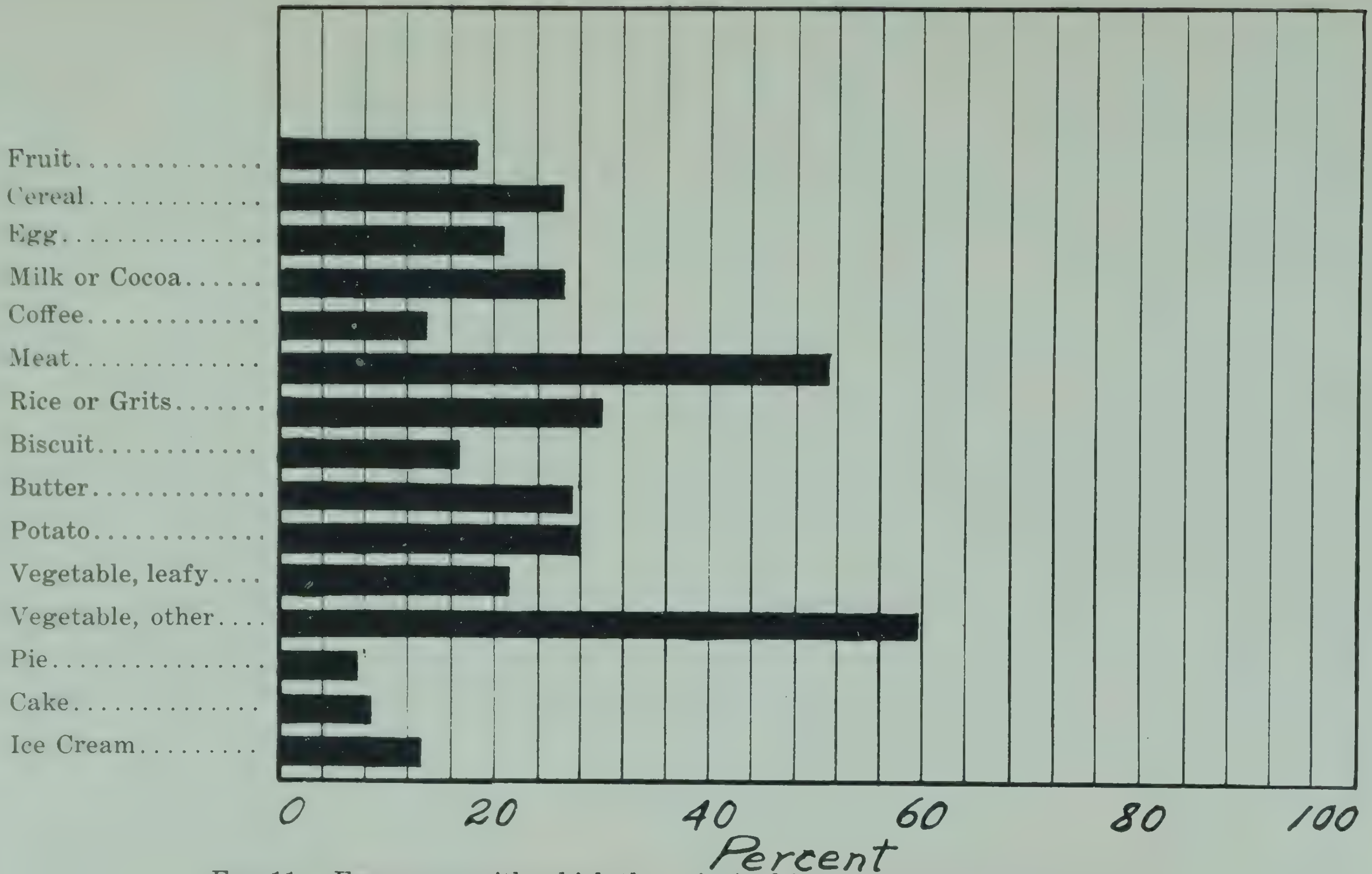

FIG. 11.—Frequency with which the principal items appear in dinner menus.

of the children scored less than 40 for the principal meal of the day. A score of 35 or less represents an inadequate diet. A score of 40-50 for the dinner menu was considered as a ration of questionable adequacy. In this group there were 26 percent of the children. About 18 percent of the menus were in a group the score of which was 50 or above, these being considered as adequate.

TABLE XIII.—FREQUENCY WITH WHICH CERTAIN FOODS OCCUR IN DINNER MENUS.

Food	Number	Percent
Fruit	391	18.5
Cereal	551	26.2
Egg	442	20.9
Milk or Cocoa	560	26.5
Coffee	285	13.5
Meat	1,078	51.0
Rice or Grits	627	29.7
Biscuit	344	16.3
Butter	570	27.0
Potato	596	28.0
Vegetable (leafy)	456	21.6
Vegetable (other)	1,252	59.3
Pie	154	7.3
Cake	180	8.5
Ice Cream	280	13.2
Total Number of Dinners	2,110	

TABLE XIII-a.—DINNER SCORES.

Scores	Number	Percent
No dinner	20	0.9
5-15	113	5.3
20-35	803	38.7
40-50	795	37.8
55 and over	379	18.0
Total Number of Dinners	2,110	

A general survey of these data on menus shows that some of the factors responsible for so large a percentage of inadequate diets were the scanty use of milk, leafy vegetables and fruit. The extensive use of rice, vegetables other than leafy, grits and meat, especially bacon, is a fault in so many of the dietaries, for when these items are not served there is a tendency toward greater use of the more essential foods.

DIETS AND PHYSICAL DEFECTS

The customary method of grading nutrition is based upon height-weight ratios. An effort was made in this study to use weight as a criterion of the state of nutrition of the children and as an index of the type of food used. After a careful study of Tables VI, VII, VIII, IX and XIV, it was found that other factors in addition to diet affect weight. According to Roberts (7), "children that are above or equal to the average weight tend to remain in that group, and those that are below the average tend to remain below the average." From the results obtained in this survey it can be definitely stated that the height-weight relation is not an index of the health of the children, nor is it a criterion by which the diets could be judged. The reasons for this statement are as follows: (1) The study of the diets of 2,045 children for whom weights were obtained fails to show that the grade of the diet has a significant influence on weight. (2) The following physical defects influence weight: (a) hookworm infestation, (b) abnormal tonsils, (c) thyroid disturbances.

DIETS AND WEIGHT

As stated previously, the various food types of the menus were given numerical values and on this basis the diets were scored. Table XIV points out clearly that the scores for these menus show little relation to weight. The children were divided into three weight groups, underweight, overweight and correct weight. In each weight group each type of diet is found. In the extremely deficient diet group, 2.6 percent of the underweight children, 1.4 percent of the overweight children and 0.7 percent of the children with correct weight, were found. In the inadequate group very little difference was found between the percent of overweight and underweight children, 23.6 percent of the underweight children had inadequate diets as compared to 23.8 percent for the overweight group. On the other hand, 32.0 percent of the children in the group with correct weights had inadequate diets. In the group, diets of questionable adequacy, no relation of diet to weight exists. It is true that there are more underweight than overweight children in this diet group, but again there are more overweight children than children with correct weight. No very great difference was found in the adequate group, although the trend here points to the fact that underweight decreases with improved diet, 20.0 percent of the underweight children having an adequate diet as compared to 23.3 percent of the children with correct weight. However, this difference is not great enough to warrant the conclusion that diet is an important factor in weight relations. In the commendable group there were more underweight children than children with correct weight.

It is evident from Table XIV, that for each weight group the scores for the diets vary very little, and that the grade of diet has little influence on weight.

TABLE XIV.—RELATION OF DIET TO WEIGHT.

Score		Extremely Deficient 5-15		Inadequate 20-35		Questionable 40-55		Adequate 60-80		Commendable 85-100	
	No.	No.	%	No.	%	No.	%	No.	%	No.	%
Total	2,045	28	1.3	582	28.4	934	45.7	477	23.4	24	1.1
Underweight	562	15	2.6	133	23.6	288	49.4	119	20.0	7	1.2
Overweight	295	4	1.4	68	23.8	138	46.9	80	27.0	5	1.7
Correct Weight	1,188	9	0.7	381	32.0	508	42.7	278	23.3	12	1.0

DIET AND ANEMIA

The diets of 514 anemic children were tabulated and scored. In Table XV are given the scores of the diets and the number of anemic children in each of the diet groups. According to these data there is a relation between anemia and improper diet; 3.5 percent of the anemic children have extremely deficient diets, 40.2 percent have inadequate diets, 39.1 percent have questionable diets, while only 17.0 percent have adequate diets.

This table also shows that diet is more closely related to anemia than it is to weight. The percent of anemic children with adequate diets is lower than the percent of underweight children with adequate diets. Also, 2.6 percent of underweight children have extremely deficient diets as compared to 3.5 percent of anemic children in the same diet group. A much more striking difference is shown for the inadequate group; 23 percent of the underweight children fall into this group, while 40.2 percent of the anemic children have inadequate diets.

A study of the menus also substantiates this view. The use of food of high calorie value was found to be more prevalent in this study than the use of food which is high in mineral content, such as fruit, vegetables and milk. These data, then, show that improper diet is one of the causative factors in anemia.

TABLE XV.—DIET SCORES OF ANEMIC AND UNDERWEIGHT CHILDREN.

Score	Anemic Children		Underweight Children	
	No.	%	No.	%
5- 15	18	3.5	15	2.6
20- 35	207	40.2	133	23.6
40- 55	201	39.1	288	49.4
60- 80	84	16.3	119	20.0
85-100	4	0.7	7	1.2

PHYSICAL DEFECTS WHICH INFLUENCE WEIGHT

In addition to the study made to determine the influence of diet on weight, tabulations were made to ascertain what relationship, if any, exists between abnormal weight and physical defects. It was shown in Tables VI, VII and IX that hookworm infestation, abnormal tonsils, and thyroid disturbances are causative factors for overweight and underweight.

HOOKWORM INFESTATION

To judge the state of nutrition and health by height-weight ratio exclusively would be very misleading, as shown by Table XVI. The tabulations here show that, although a child may have the correct weight for his height, he is not necessarily a well-nourished child nor can it be concluded that he is in the best of health. The following relation stands out clearly: hookworm infestation contributes to a condition of overweight and not to underweight. Table XVI shows that 71.6 percent of the overweight children are hookworm infested, while only 38.1 percent of those who are underweight are hookworm subjects. It should also be borne in mind that 56.6 percent of the children who have the average weight for their height have been found as positive hookworm children. Thus it cannot be concluded that because the height-weight ratio is correct the child needs no further physical examination. This condition alone shows that too much stress should not be placed on height-weight relations in judging the physical condition of children, especially in areas where hookworm infestation is prevalent.

TABLE XVI.—WEIGHT—HOOKWORM RELATION.

Condition	Both Sexes		Boys		Girls	
	No.	%	No.	%	No.	%
Total number examined	3,325	....	1,577	....	1,748	....
Total number with weights	3,027	....	1,415	....	1,612	....
Total number overweight	380	12.3	140	9.9	240	14.9
Hookworm—overweight	272	71.6	112	80.0	160	66.6
Total number underweight	977	32.3	431	30.5	546	33.9
Hookworm—underweight	375	38.1	195	45.2	180	32.9
Total number correct weight	1,670	55.4	844	59.6	826	51.2
Hookworm correct weight	946	56.6	550	65.1	396	47.9

DEFECTIVE TONSILS

From a study of Table VI it will be noted that 58.0 percent of the children with defective tonsils are underweight. The percentage of underweight children free from defects of tonsils is 13.0 percent. These data show that defective tonsils contribute to underweight conditions.

THYROID DISTURBANCES

Another factor which influences weight is the condition of the thyroid gland. These data show that of the 77 children with thyroid disturbances, 56, or 73.0 percent, are underweight. It must be recognized that this defect occurs in a small percentage of cases and does not affect the average weight of a large group.

On a basis of the effect of factors other than diet, height-weight ratios cannot be used as an index regarding the diet. Thus in order to study the effect of diet on general health and underweight, these other factors must be eliminated.

DIET AND TEETH

A study of the relation of diet to teeth was made of 406 children of one county. As shown in Table XVII, 53.8 percent of the children using milk had teeth which were not defective, while only a little more than 10 percent of the children who did not use milk had good teeth. The incidence of carious teeth was twice as common for the children who did not use milk as for those who did. Chalky teeth were also more prevalent in the group not using milk.

The smallness of the number does not permit of any positive correlation between the use of milk and the condition of the teeth. However, the differences for the group using milk as compared to those not using milk undoubtedly are significant.

TABLE XVII.—Milk and the Condition of the Teeth.

Condition of Teeth	Children Using Milk		Children not Using Milk	
	No.	%	No.	%
Total	186	....	220	....
Teeth not defective	100	53.8	22	10.0
Carious teeth	62	33.3	146	66.4
Chalky teeth	8	4.3	32	14.5
Malocclusion	16	8.6	20	9.1

SUMMARY

In this study of the physical condition and dietary habits of 3,325 children of five representative counties in Florida, the following points are of interest:

1. A very favorable showing was made for children free from defects.

2. The percent of girls with defects is lower than the percent of boys. This is due to the fact that the percent of boys with carious teeth, defective tonsils and hookworm infestation is greater than the percent of girls with these defects.

3. The data for height and weight show that, for a given age, these children are in general below the average in height and weight up to the age of 14.

4. More than 45 percent of the children were found to have the following defects: carious teeth, abnormal tonsils and hookworm

infestation; while more than 30 percent of the children were found with enlarged lymph glands, conjunctivitis, abnormal weight relations, and anemia.

5. Heart defects were found in slightly more than 12 percent of the children. This value is far above the average reported in other studies.

6. It was found that among the children with hookworm infestation and defective tonsils, heart defects and anemia were almost three times as great as in children free from these defects. Among the anemic children, defective tonsils, hookworm infestation, conjunctivitis, heart defects and underweight conditions were much more prevalent than among children not anemic.

7. An analysis of the data on diets shows that less than 25 percent of the children have adequate diets. However, the surprising lack of underweight children, living on extremely deficient or inadequate diets, must be emphasized.

8. Underweight is found evenly distributed among the different diet groups.

9. The data point out a relation between anemia and diet, anemia being much more prevalent in the group of children with inadequate diets.

10. These data show that diet does matter, even though children whose diets were deficient in many respects were found to be of normal weight. Such diets, if continued, cannot fail to work havoc in some way, although they do not always cause underweight; as shown in this study anemia is likely to be one of the abnormal conditions to make itself manifest.

11. If weight alone is a standard of nutrition, many children who have serious defects, as hookworm infestation, abnormal tonsils, and heart defects must be regarded as in "good condition."

CONCLUSIONS

Hookworm infestation and defective tonsils are defects which should be corrected, since these are causative factors in many abnormal conditions, if the aim of nutrition workers is better health. As a criterion of the condition of nutrition, the weight to height ratio alone is not sufficient.

General education in food requirements and methods of preparing suitable foods is also of immediate importance, but before any significant change in nutrition can be brought about, physical defects must be eliminated or controlled.

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UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
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FLORIDA TRUCK CROP COMPETITION

I. Inter-State and Foreign

By C. V. NOBLE AND MARVIN A. BROOKER

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FLORIDA TRUCK CROP COMPETITION

I. Inter-State and Foreign

By C. V. Noble and Marvin A. Brooker

ECONOMIC IMPORTANCE OF FLORIDA TRUCK CROPS

The farm value of all Florida truck crops ranks close to the farm value of Florida citrus crops.[1] The average seasonal estimated farm value of all Florida citrus from 1924-1925 to 1928-1929, inclusive, was approximately $41,500,000, whereas the average estimate for 12 of the leading truck crops of the state for the same period was about $35,000,000 (Table I). Adequate farm value data for all truck crops produced in Florida are not available, therefore the 12 crops shown in Table I are used to bring out the importance of truck farming in Florida. It is estimated that these 12 crops represent between 90 and 95 percent of the total farm value of all Florida truck crops. The relative importance of Florida in the production of these 12 crops is shown in Table II. For the five-season period ending with 1928-1929, Florida ranked first among the states in the combined farm value of the 12 truck crops enumerated in Table II. For the individual crops, Florida took first place in farm value with six, namely, string beans, celery, cucumbers, eggplants, peppers, and tomatoes; second only to Georgia with watermelons; and third with white potatoes among the early and second early states, being surpassed by Virginia and New Jersey. Florida's marketing competition for potatoes with these two states is very slight, however. For this same five-season period, Florida had 11 percent of the total United States acreage in these 12 truck crops and received 15 percent of their total farm value. It will be noted in Table II that with 10 of the 12 crops Florida's percentage of their total value exceeded appreciably her percentage of

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Most of the data upon which this study is based were obtained from the files of H. A. Marks, Agricultural Statistician, United States Department of Agriculture, for Florida. He also cooperated freely in offering suggestions and constructive criticism as the study progressed. The writers wish to express their indebtedness to Mr. Marks and to all others who have assisted in the work in any way.

[1] All farm values computed from Crops and Markets, U.S.D.A., and include costs of picking, hauling, and packing.

TABLE I.—ACREAGE AND FARM VALUE OF 12 OF THE LEADING FLORIDA TRUCK CROPS.*
(Seasons 1924-1925 to 1928-1929)

	Acreage					
Crop	1924–25	1925–26	1926–27	1927–28	1928–29	Average
Beans, string	20,530	16,010	19,690	28,810	21,020	21,212
Cabbage	4,650	3,660	3,010	2,900	6,500	4,144
Celery	4,320	3,520	4,240	5,380	6,500	4,792
Cucumbers	10,830	7,590	7,720	9,420	11,060	9,324
Eggplants	1,400	1,020	730	1,550	1,280	1,196
Lettuce	3,400	1,500	1,840	1,850	1,970	2,112
Peas, green	2,250	760	700	1,230	1,320	1,252
Peppers	3,560	3,370	2,700	6,410	5,700	4,348
Potatoes, white	21,920	23,070	28,000	30,000	22,000	24,998
Strawberries	4,240	2,980	3,680	3,670	5,640	4,042
Tomatoes	33,470	20,700	29,800	29,260	36,980	30,042
Watermelons	22,100	24,150	29,420	37,840	36,390	29,980
Total	132,670	108,330	131,530	158,320	156,360	137,442
	Farm Value in $1,000 (i.e., 000 omitted)					
Beans, string	$ 4,191	$ 3,982	$ 3,818	$ 3,295	$ 3,569	$ 3,771
Cabbage	838	1,066	459	591	1,310	853
Celery	4,480	3,960	3,969	6,243	5,031	4,737
Cucumbers	2,964	2,781	2,074	2,272	3,004	2,619
Eggplants	499	525	301	339	516	436
Lettuce	1,079	557	476	506	467	617
Peas, green	244	107	119	170	165	161
Peppers	1,916	2,578	1,292	2,568	2,808	2,232
Potatoes, white	4,729	8,275	5,410	5,588	4,543	5,709
Strawberries	2,095	1,930	2,001	1,798	2,730	2,111
Tomatoes	8,855	8,475	7,257	10,925	8,895	8,881
Watermelons	3,382	2,765	2,524	3,111	2,913	2,939
Total	$35,272	$37,001	$29,700	$37,406	$35,951	$35,066

*Compiled from Crops and Markets, U.S.D.A., Vol. 5, No. 12, and Vol. 6, No. 12.

TABLE II.—FLORIDA'S PERCENTAGE OF THE TOTAL UNITED STATES ACREAGE AND FARM VALUE FOR 12 OF THE LEADING TRUCK CROPS.*
(Average for 5 Seasons 1924-1925 to 1928-1929)

Crop	Acreage (Percent)	Farm Value (Percent)	Rank in Value Among States
Beans, string	26	33	1
Cabbage	3	5	9
Celery	19	37	1
Cucumbers	22	36	1
Eggplants	34	51	1
Lettuce	2	2	6
Peas, green	2	2	9
Peppers	27	52	1
Potatoes, white, early and second early	7	12	3
Strawberries	2	5	9
Tomatoes	22	29	1
Watermelons	16	26	2
12 Crops	11	15	1

*Compiled from Crops and Markets, U.S.D.A., Vol. 5, No. 12, and Vol. 6, No. 12. Crops for manufacture or canning not included.

their total acreage. In fact, the average farm value per acre of these 12 crops for Florida for the five seasons exceeded that for the United States by 47 percent (Table III). It will be noted that the farm value per acre for each Florida crop exceeded similar values for all states with the exception of green peas. In case of strawberries, the farm value per acre in Florida was more than double that for all states.

The principal explanation of the high acreage value of Florida truck crops is the fact that Florida is one of the nation's winter truck gardens. Because of favorable climatic conditions, her truck crops enjoy certain periods of the season which are free from competition from other areas and, therefore, command a high price. Another reason is that the yield per acre of Florida truck crops averages better than that for the United States as a whole. In Table IV it is shown that for 6 of the 12 truck crops under discussion, the five-season average yield per acre for Florida exceeds similar yields for the nation as a whole. Of the 12 crops shown, green peas seem to respond the least favorably to Florida soil and climatic conditions. This is perhaps the principal reason for the relative unimportance of this crop in Florida. Lettuce, on the other hand, had an average yield per acre in Florida of 14 percent above the United States yield, but the price per unit was only 5 percent above the average for the nation. The principal cause for this is that consumers will pay more for the Iceberg type, or hard head lettuce, than for the Butterhead type grown in Florida, and a variety of the hard head type has not as yet been found that can be produced economically in Florida. All the other Florida crops shown in

TABLE III.—FARM VALUE PER ACRE OF 12 OF THE LEADING FLORIDA TRUCK CROPS COMPARED WITH SIMILAR VALUE FOR ALL STATES.*
(Average for 5 Seasons 1924-1925 to 1928-1929)

Crop	Farm Value per Acre		Florida's Percent of U. S. Value
	Florida	United States	
Beans, string	$178	$143	124
Cabbage	206	151	136
Celery	988	509	194
Cucumbers	281	172	163
Eggplants	365	247	148
Lettuce	292	245	119
Peas, green	129	149	87
Peppers	513	268	191
Potatoes, white, early and second early	228	143	159
Strawberries	522	254	206
Tomatoes	296	222	133
Watermelons	98	59	166
Average	$255	$174	147

*Compiled from Crops and Markets, U.S.D.A. Vol. 5, No. 12 and Vol. 6, No. 12. Crops for manufacture or canning not included.

Table IV received an appreciable unit price premium over that for the United States as a whole. The fact that Florida truck growers usually receive a price premium for their products over producers for the nation as a whole is no proof that they are receiving larger profits. Unfortunately, adequate cost of production data are not available from the different producing areas to make reliable estimates of net returns. Florida is also at a disadvantage in the matter of transportation rates, as has been brought out in another publication from this Station.[2] Although the transportation study covered citrus crops, the results apply in a general way to other fruits and vegetable crops.

TABLE IV.—YIELDS PER ACRE AND PRICE PER UNIT FOR 12 OF THE LEADING FLORIDA TRUCK CROPS COMPARED WITH THE UNITED STATES.*
(Average for 5 Seasons 1924-1925 to 1928-1929)

Crop	Yield per Acre		Florida's Percent of U. S. Yield	Price per Unit		Florida's Percent of U. S. Price
	Florida	United States		Florida	United States	
Beans, string	70 bu.	84 bu.	83	$ 2.64	$ 1.73	153
Cabbage	5.8 tons	7.7 tons	75	35.66	18.95	188
Celery	412 cr.	290 cr.	142	2.46	1.76	140
Cucumbers	116 bu.	127 bu.	91	2.50	1.37	182
Eggplants	294 bu.	238 bu.	124	1.29	1.05	123
Lettuce	181 cr.	159 cr.	114	1.63	1.55	105
Peas, green	48 bu.	77 bu.	62	2.86	1.92	149
Peppers	339 bu.	244 bu.	139	1.56	1.11	141
Potatoes, white, early and second early	118 bu.	121 bu.	98	1.97	1.23	160
Strawberries	1845 qts.	1671 qts.	110	.29	.16	181
Tomatoes	97 bu.	123 bu.	79	3.21	1.82	176
Watermelons	337	326	103	305[2]/	183[2]/	167

*Compiled from Crops and Markets, U.S.D.A. Vol. 5, No. 12 and Vol. 6, No. 12. Crops for manufacture or canning not included.

[2] Per car of approximately 1000 melons.

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[2] A study of the cost of transportation of Florida citrus fruits with comparative costs from other producing areas. Florida Experiment Station Bulletin 217.

PURPOSE OF STUDY

Because of the great importance of truck crops in Florida agriculture, this study was made to bring out the week-to-week competition between Florida growers and producers from the other states as well as from foreign countries. If this information is before the growers of Florida, it is the thought that they will be in a much better position to plan their plantings in order to reduce to a minimum the disastrous peaks of overproduction. It is realized that climatic factors determine to a considerable extent the production period for each truck crop, but frequently a shift of a week to two weeks in the marketing season determines whether the crop is to prove a success or failure.

SOURCE OF DATA

All data for this study were obtained from the "Weekly Summary of Car-lot Shipments" issued by the United States Bureau of Agricultural Economics. These data include an estimate of all boat shipments reduced to car-lot equivalents, but do not throw any light upon the quantities of truck crops used in the local Florida markets. There is also no estimate made to cover the movement by less than car-lot freight, by express or by motor trucks.

PERIOD COVERED

While the seasons for marketing most Florida truck crops are fairly constant, there is some variation from year to year of the date at which the first products come on the market, and the peak of the marketing season. The dates at which competition from other states and from imports become of importance vary also over a period of a few days for some crops to several weeks for others. While it is generally true that when crops are late in Florida they are also late in competing states, and vice versa, it is believed that data for one or two years would not give a correct picture of Florida's truck crop competition. Therefore data for a period of five years, from 1924-25, to 1928-29, inclusive, have been studied carefully to show the periodic competition which Florida products meet on the market and the trends of this competition.[3]

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[3] Since this study was completed, data for the 1929-30 season have become available and are included in the appendix as supplemental data.

METHODS OF PRESENTATION

Data showing the competition which Florida truck growers meet in the markets are presented in both chart and tabular form. Charts have been prepared for each commodity which show the week-to-week competition which Florida producers have met yearly during the period 1924-25 to 1928-29, inclusive, from all competing states and foreign countries. The data from which these charts were prepared are included as an appendix for the benefit of those who desire to make further analyses.

SEASONAL PRODUCTION

The demands of consumers for larger and more constant supplies of fresh fruits and vegetables throughout the year have led to greatly increased production of these commodities. The local vegetable gardens are no longer sufficient to supply the home markets, since production in any given area is seasonal while the period of consumption of a product occupies a much longer period of time. During the spring and summer a large part of the agriculture of the United States is devoted to the production of fresh fruits and vegetables for use on the farm and in the cities. Enormous quantities are shipped great distances under refrigeration from the better producing areas. Large quantities, also, are canned or stored for winter consumption.

During the winter months only limited areas of this country are climatically adapted to the commercial production of fresh fruits and vegetables. For a number of truck crops, during this period of the year, Florida has very nearly a monopoly on the supply available to northern markets. As the season advances, however, states to the north of Florida come into production. During the winter and early spring these products are always expensive to the ultimate consumer, but due to the great distance of the Florida producing areas from the centers of consumption, and the attendant high transportation costs, Florida producers do not always receive a profit. Retail prices that would result in substantial profits to producers in Tennessee, Maryland, or New York, might prove unprofitable to Florida producers. For this reason, when states to the north of Florida begin sending large supplies of produce to the northern markets, Florida is largely eliminated.

While it is physically possible to extend the season for most

Florida truck crops later into the summer than is usually done, it is doubtful if such a policy would prove profitable. Late shipments from Florida come in contact with strong competition from states more favorably located with regards to the markets, and any extension of the Florida season at that period of the year would meet increasing competition. There is a definite period to which Florida producers can fit their shipments of fresh fruits and vegetables to escape the bulk of competition from other states. To produce quality products, economically, at this period of the year is the object of the successful Florida producer.

An examination of statistics of car-lot shipments of some of the leading truck crops from Florida in comparison with those from competing sections on a weekly basis will help to determine the most favorable period of the year for marketing Florida produce.

STRING BEANS

Florida holds first place in the total volume of production of string beans. The Florida season normally lasts from about the first of November until the first of June. During that period competition is met from about a dozen states and Cuba and Mexico. The first beans to be marketed are the fall crop from northern and central Florida which come into competition with late shipments from Louisiana, South Carolina, Virginia, North Carolina, Texas, and other states. This competition is usually over by about the first of December, when shipments begin moving in volume from south Florida.

The first competition that Florida experiences with early beans from other states comes about the middle of March when Texas begins marketing the new crop. Louisiana begins shortly thereafter, followed immediately by lesser shipments from Mississippi, Alabama, Georgia, California, and other states. Competition is rendered extremely difficult for Florida with the appearance of South Carolina on the market about the first of May, followed in quick succession by North Carolina, Virginia, and other states.

Imports of string beans are of little importance but have been increasing. During 1928-29 there were 57 carloads imported from Mexico between Christmas and the middle of February. At that season of the year Florida has no domestic competition (charts 1 to 5 and Appendix Tables I to V, inclusive).

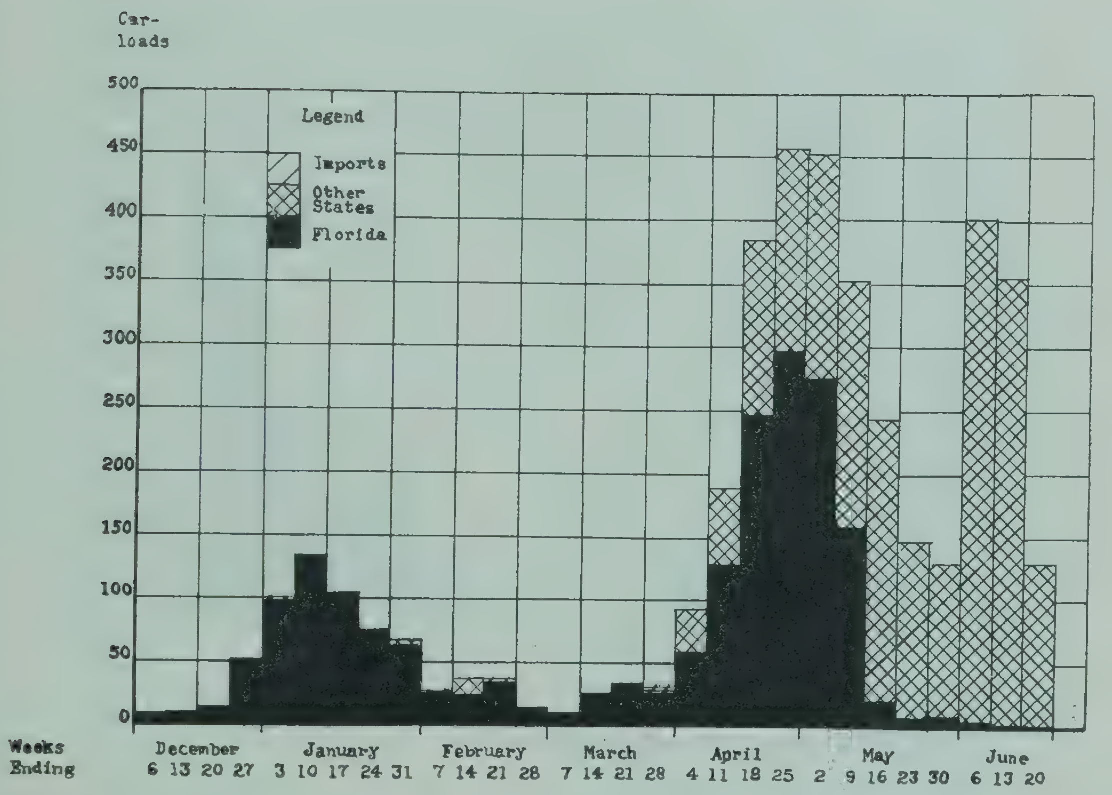

Chart 1.—Weekly car-lot shipments of string beans from Florida and total competition from other states and imports, 1924-1925 season.

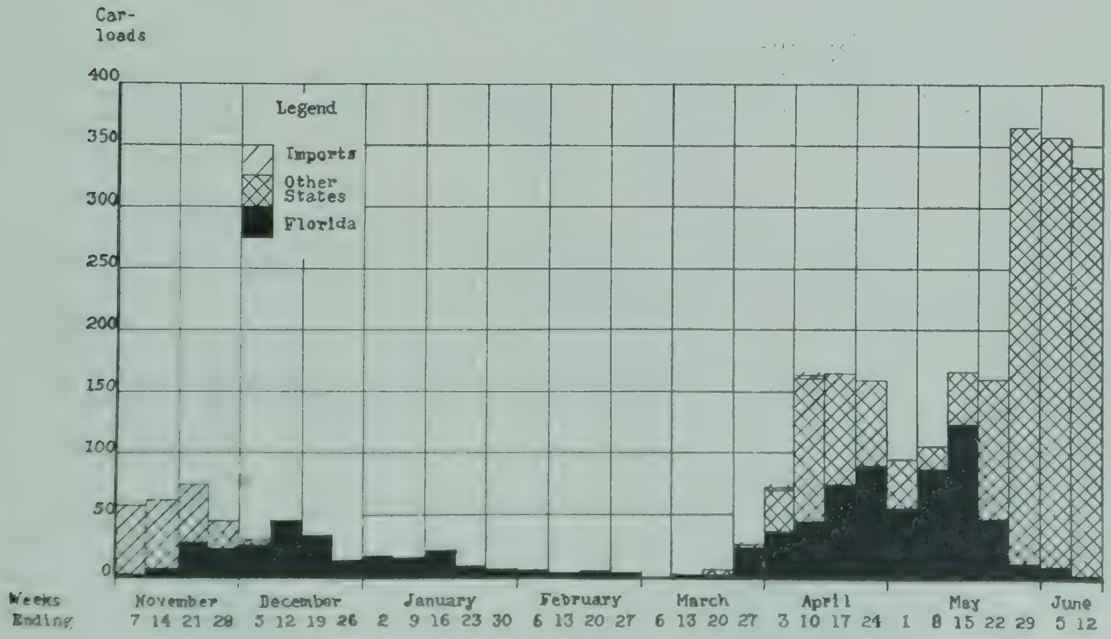

Chart 2.—Weekly car-lot shipments of string beans from Florida and total competition from other states and imports, 1925-1926 season.

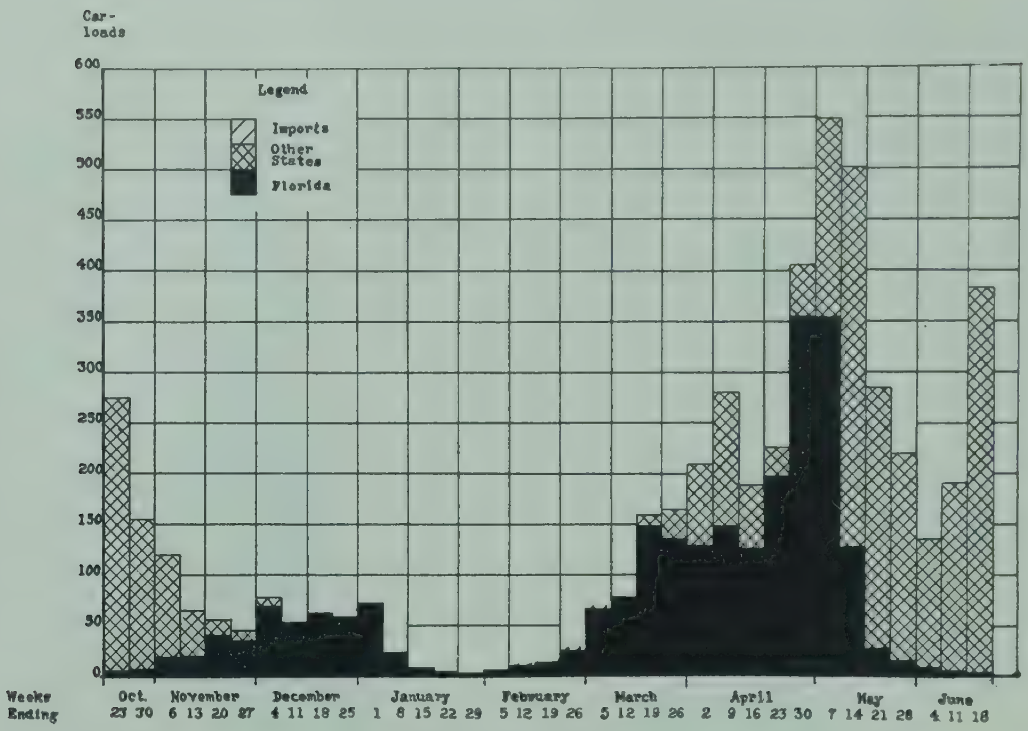

Chart 3.—Weekly car-lot shipments of string beans from Florida and total competition from other states and imports 1926-1927 season.

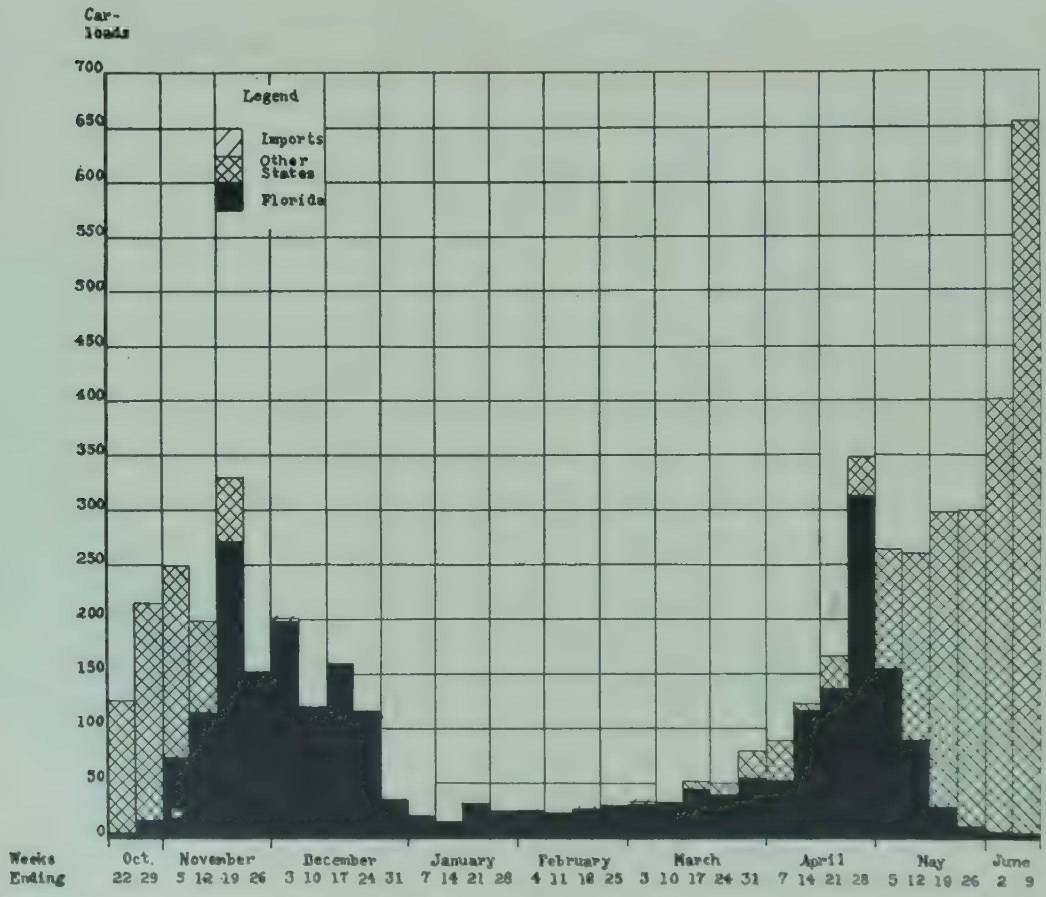

Chart 4.—Weekly car-lot shipments of string beans from Florida and total competition from other states and imports, 1927-1928 season.

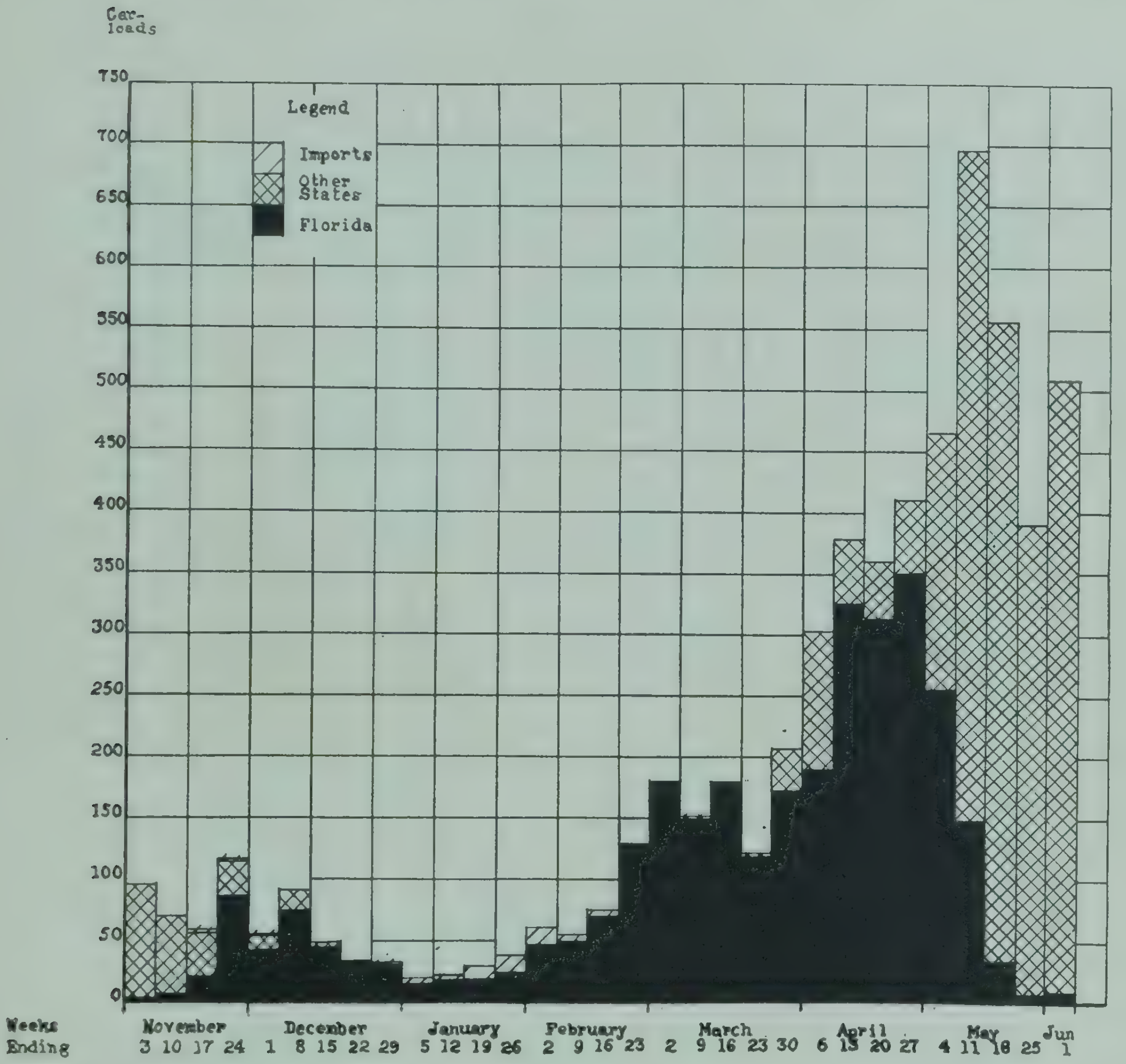

Chart 5.—Weekly car-lot shipments of string beans from Florida and total competition from other states and imports, 1928-1929 season.

CABBAGE

Cabbage production in Florida has trended slightly downward during recent years, chiefly due to a decided increase in production in Texas, the principal competing state for green cabbage. The shipping season in Texas is almost identical with that of Florida. Since the Texas crop is mostly hard cabbage that ships well in bulk without the costs for crates and packing that are necessary for the Florida crop, it offers severe competition for Florida and promises to continue to be a limiting factor in the successful marketing of the Florida crop. California also ships cabbage throughout the Florida shipping season, but the volume is not large. South Carolina and Alabama, however, ship in sufficient volume to be important competitors, while Louisiana, Mississippi, and Virginia compete near the end of the Florida season.

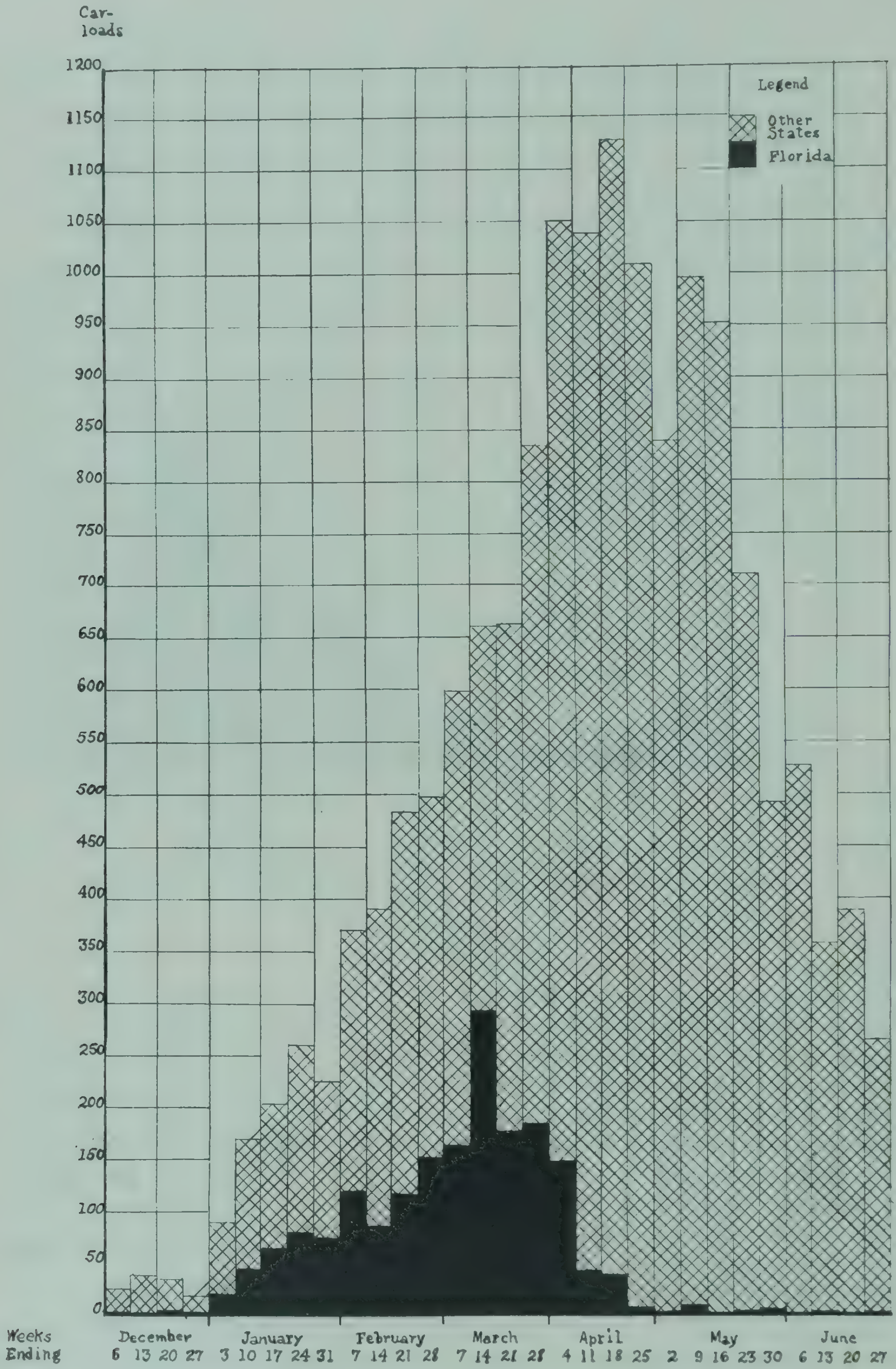

Chart 6.—Weekly car-lot shipments of cabbage from Florida and total competition from other states, 1924-1925 season.

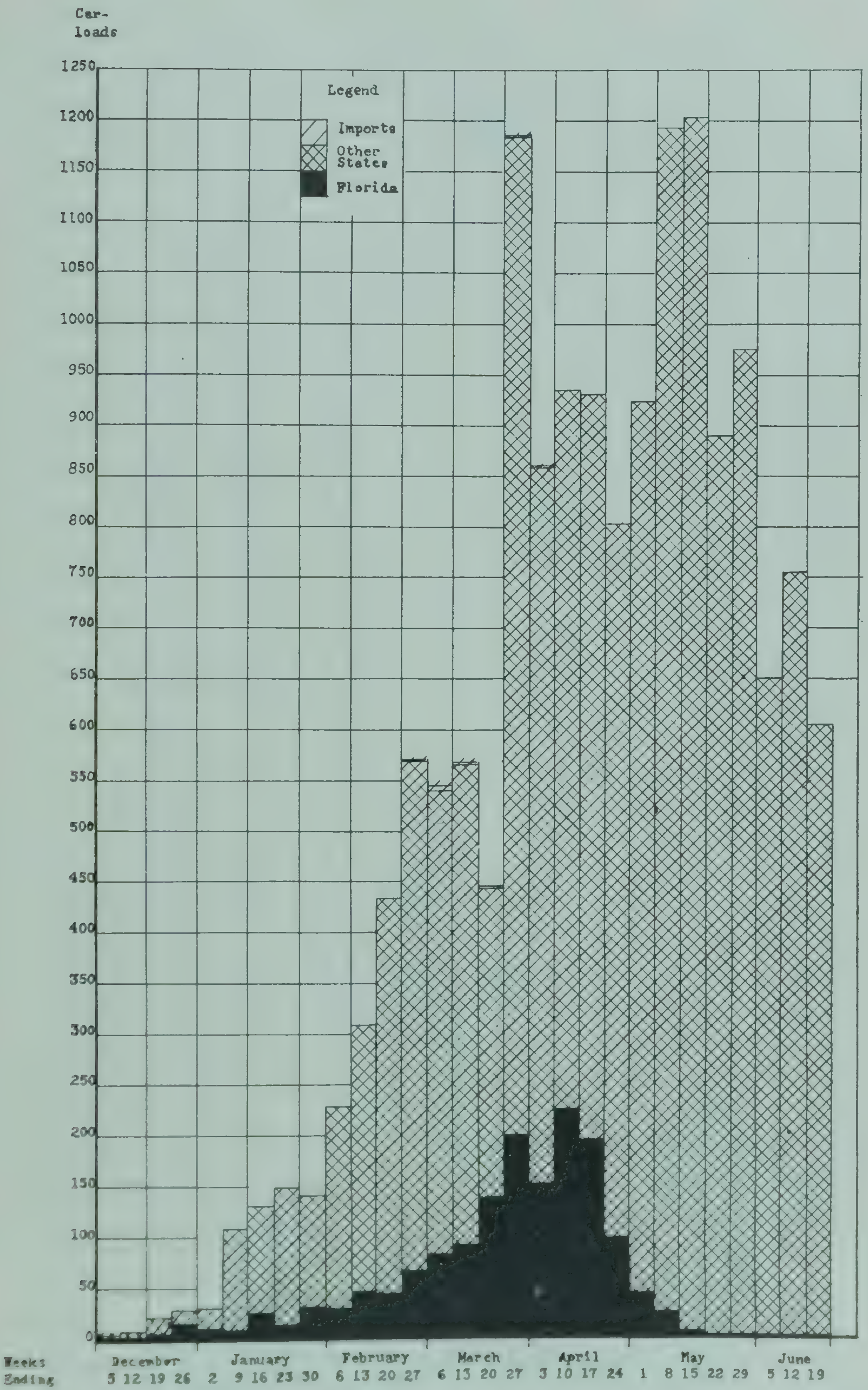

Chart 7.—Weekly car-lot shipments of cabbage from Florida and total competition from other states and imports, 1925-1926 season.

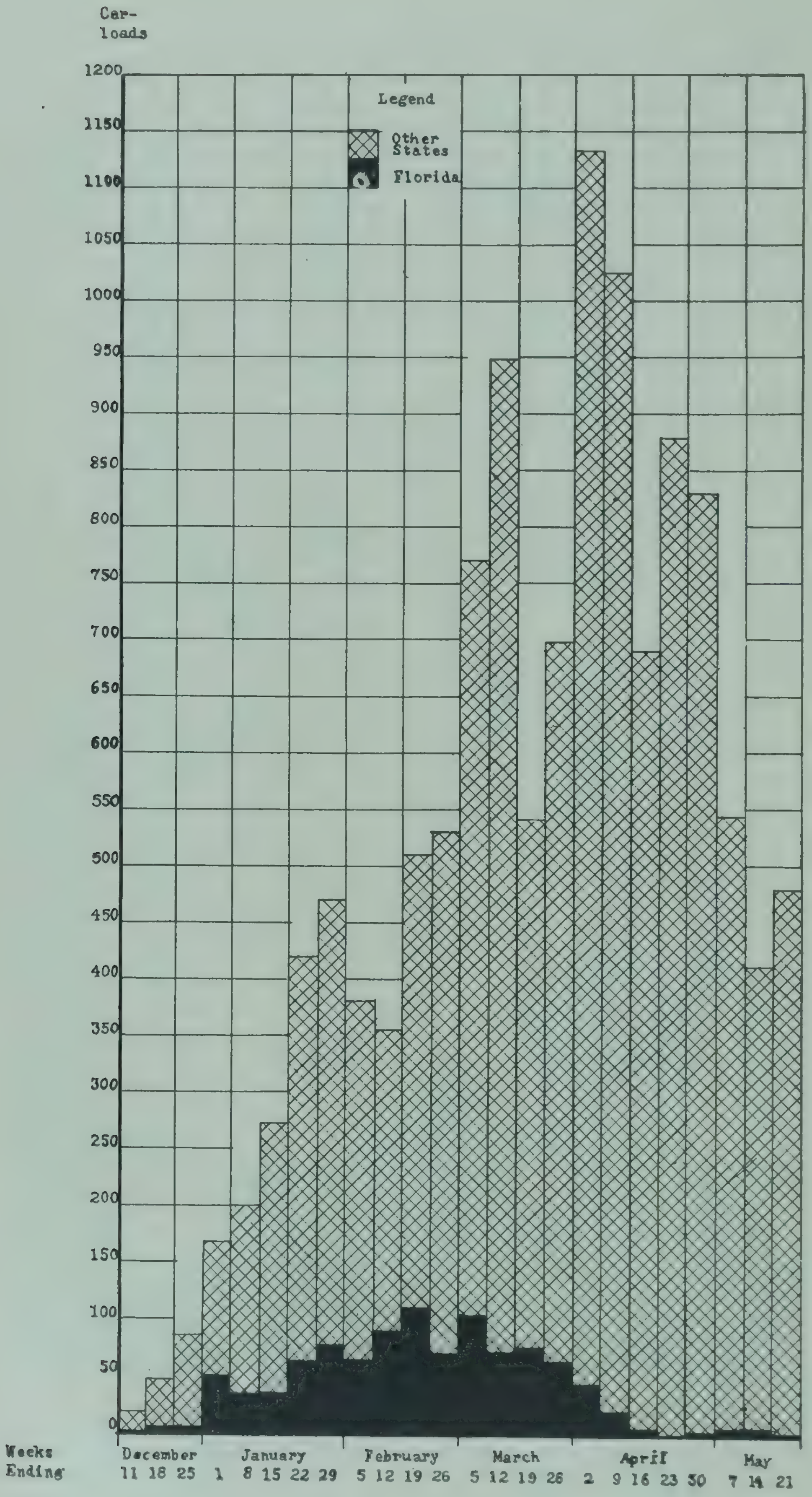

Chart 8.—Weekly car-lot shipments of cabbage from Florida and total competition from other states, 1926-1927 season.

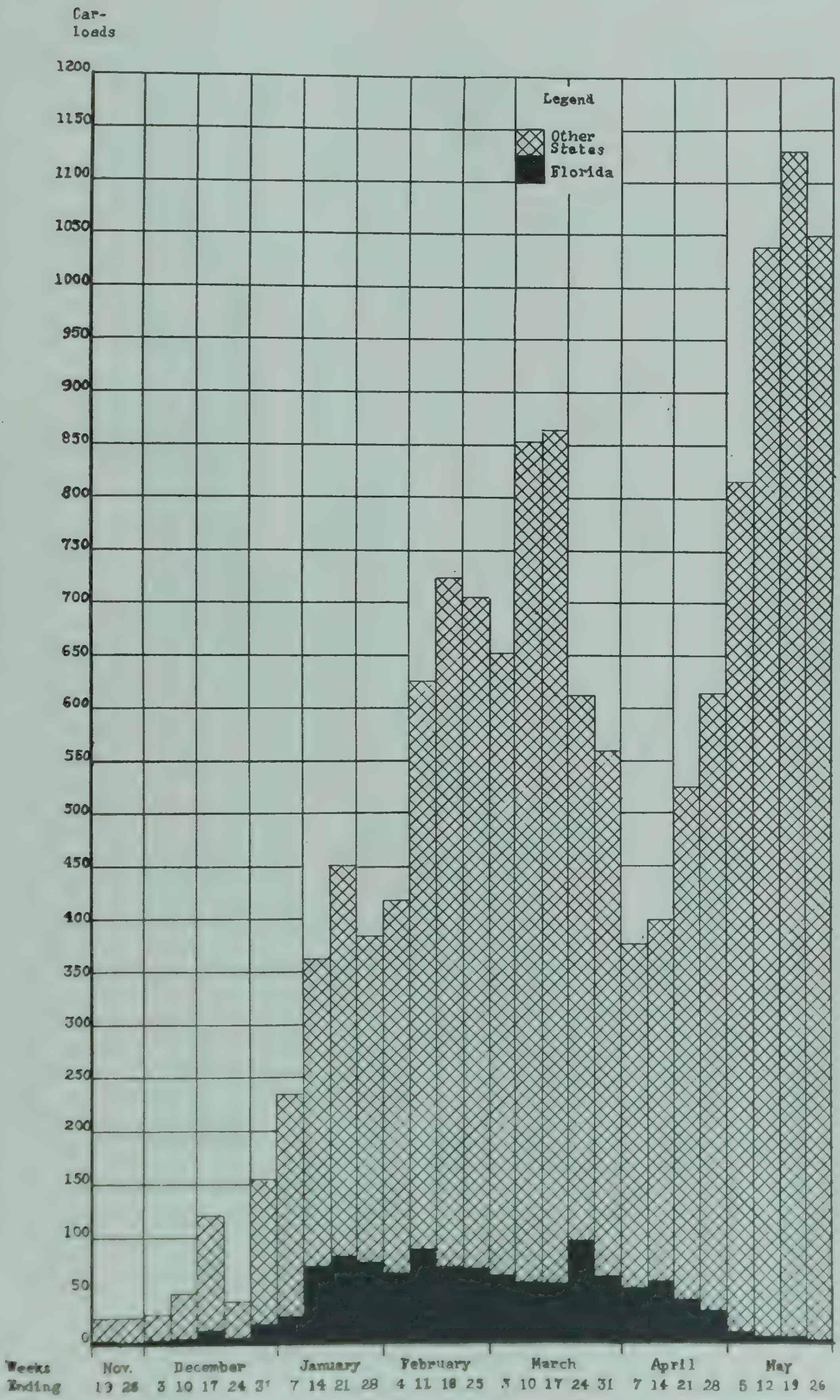

Chart 9.—Weekly car-lot shipments of cabbage from Florida and total competition from other states, 1927-1928 season.

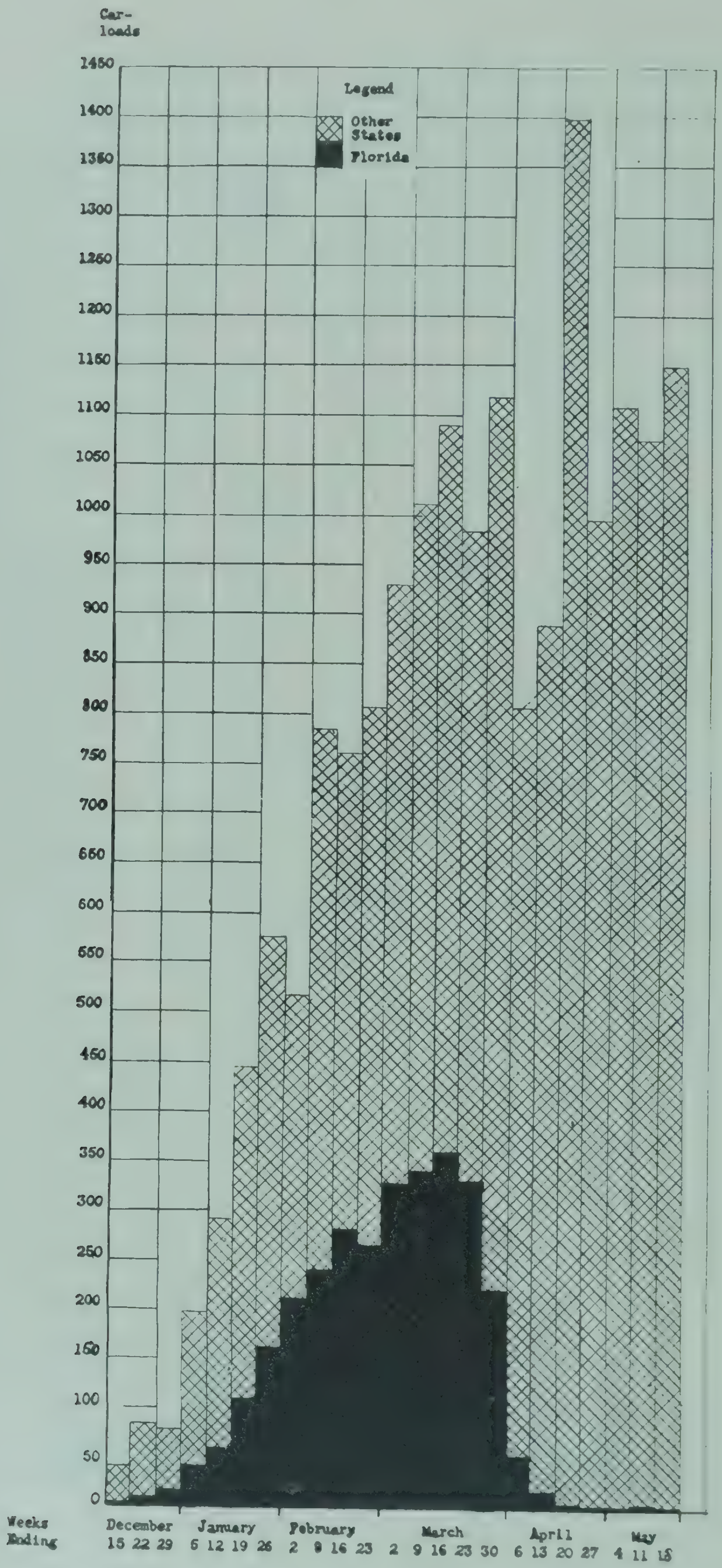

Chart 10.—Weekly car-lot shipments of cabbage from Florida and total competition from other states, 1928-1929 season.

While Florida was shipping 3,064 carloads of green cabbage in 1928-1929, 10 competing states shipped 14,053 carloads of green cabbage and 12 states shipped 4,528 carloads of stored cabbage. The Florida season began near the usual time, with three carloads shipped during the week which ended December 15, 1928, but due to heavy competition and low prices ended about the middle of May, somewhat earlier than usual. The peak of the Florida movement was reached about the middle of March. Texas was Florida's strongest single competitor in the green cabbage market, shipping a total of 7,359 carloads during the Florida season. The peak of the Texas movement was reached only slightly later than the peak of the Florida movement. California and South Carolina, likewise, were on the green cabbage market throughout the Florida shipping season, with 336 carloads and 2,490 carloads, respectively, except that South Carolina did not ship for about two weeks during the first of March because of a slight intermission between the fall and spring crop from that state. The peak of the movement from South Carolina was reached about the middle of April, thus very nearly eliminating Florida, with her greater distance and higher transportation costs, from the market. Louisiana, Virginia, Alabama, Georgia, Mississippi, and North Carolina also actively competed with Florida on the green cabbage market during this season.

Competition during the previous four seasons was similar to that described for 1928-1929, except that the movement from Florida was much lighter (charts 6 to 10, inclusive).

Formerly competition was mostly with the northern crop and plantings were guided largely by the amount of cabbage in storage, but now competition from green cabbage appears to be more important. More than two-thirds of the stored cabbage marketed during the Florida season is produced in New York. Wisconsin, Pennsylvania, and Michigan, also, ship considerable quantities of cabbage from storage. The bulk of the stored cabbage competition comes during December and January. Competition from stored cabbage is negligible after about the first of March (charts 11 to 15 and Appendix Tables VII to XI, inclusive).

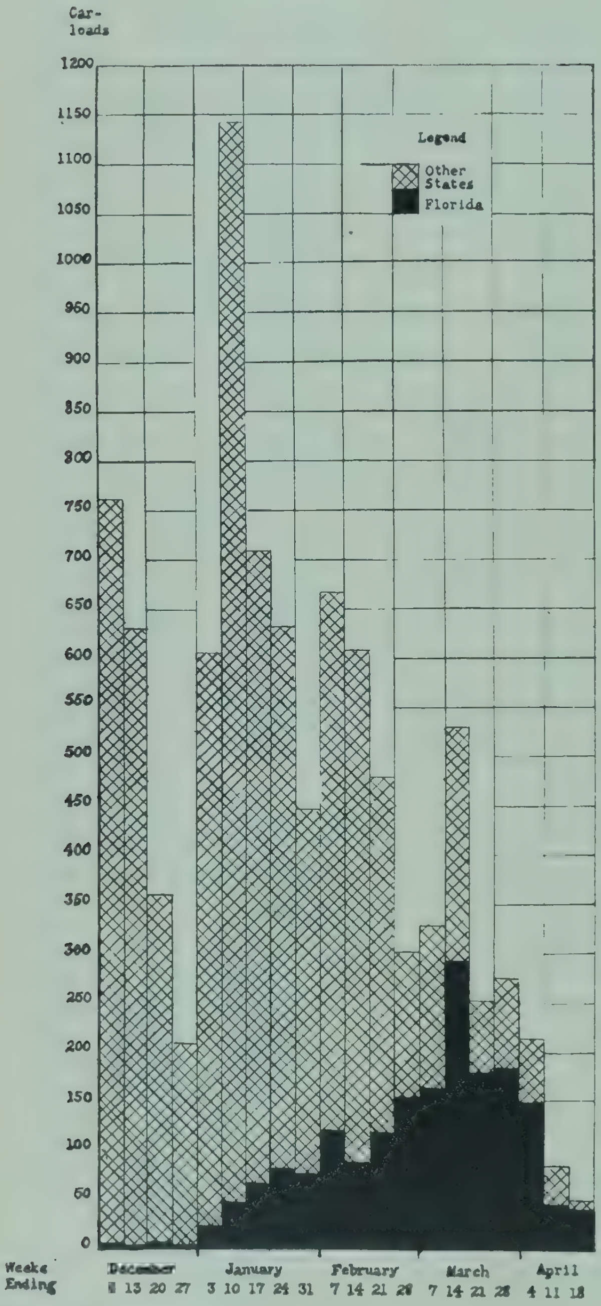

Chart 11.—Weekly car-lot shipments of cabbage from Florida with total stored cabbage competition from other states, 1924-1925 season.

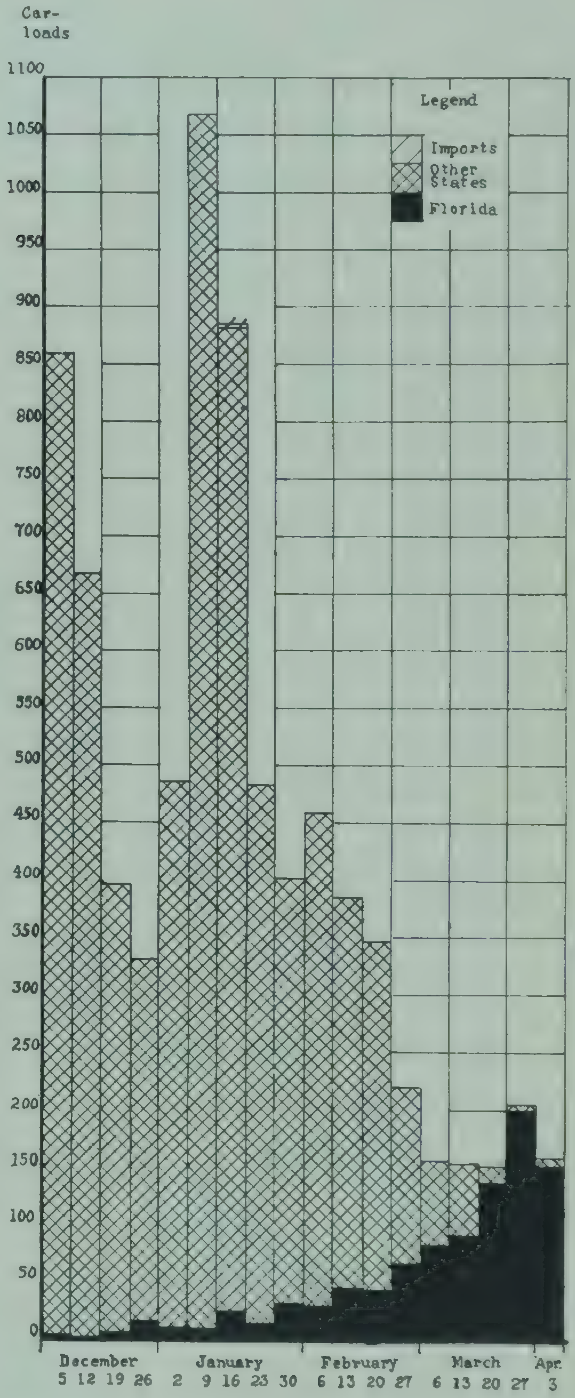

Chart 12.—Weekly car-lot shipments of cabbage from Florida with total stored cabbage competition from other states and imports, 1925-1926 season.

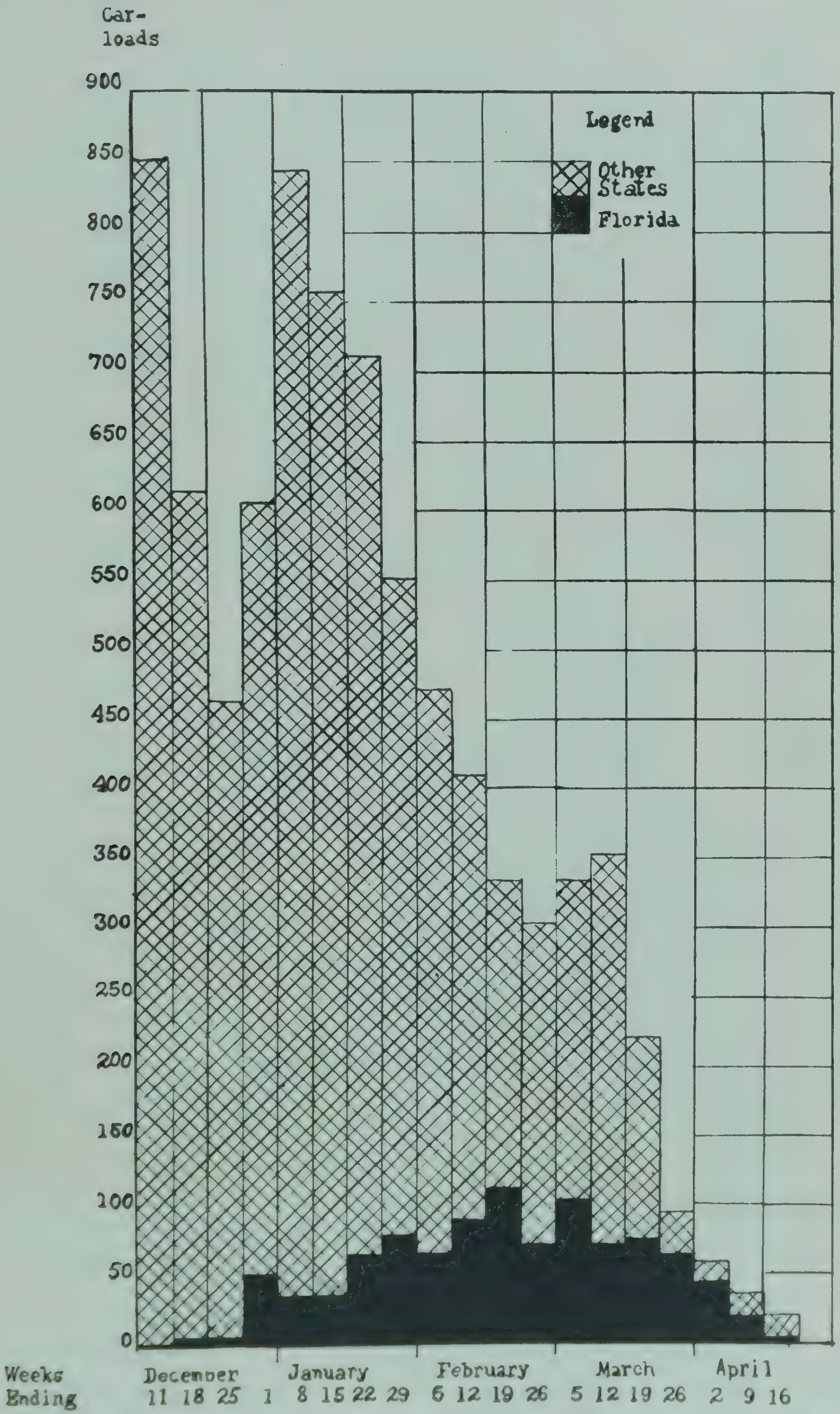

Chart 13.—Weekly car-lot shipments of cabbage from Florida with total stored cabbage competition from other states, 1926-1927 season.

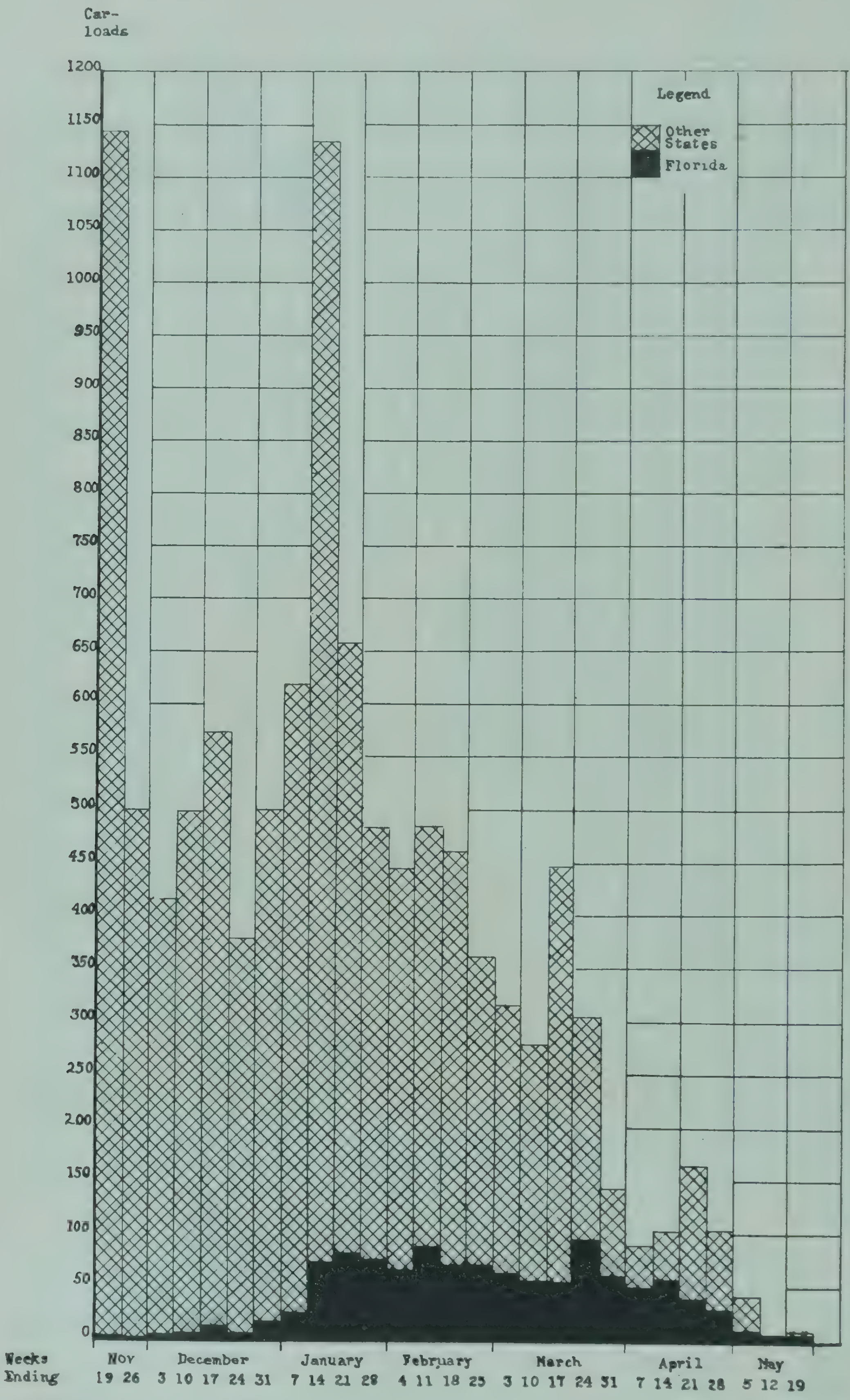

Chart 14.—Weekly car-lot shipments of cabbage from Florida with total stored cabbage competition from other states, 1927-1928 season.

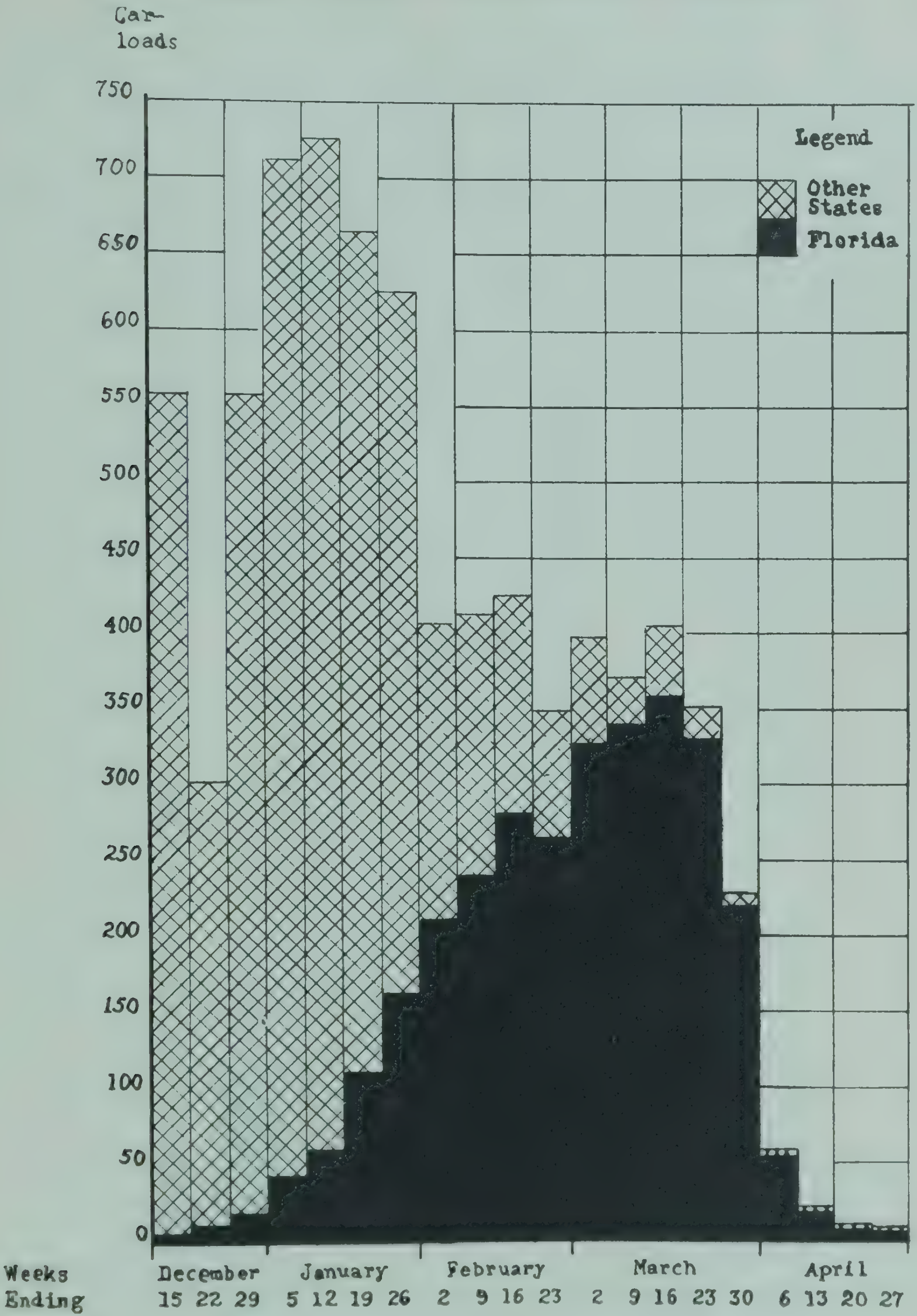

Chart 15.—Weekly car-lot shipments of cabbage from Florida with total stored cabbage competition from other states, 1928-1929 season.

CELERY

From the standpoint of value, celery ranks third in importance among Florida truck crops. During the 1929 season Florida shipped 8,871 carloads of celery, while California, her strongest competitor, was shipping 4,998 carloads. California celery was on the market throughout the entire Florida shipping season.

Florida usually moves a few cars in late December or early January, but shipments are mostly from January 15 and extend into June.

With the exception of California, Florida has practically no competition from domestic spring celery. In 1929, Oregon, Maryland, and Michigan began shipping new celery in June, but only 23 carloads were placed on the market from these sources during the Florida shipping season. Most of the celery imported into the United States, however, comes from Bermuda during May and June. This celery comes in direct competition with Florida celery, since the two shipping seasons closely coincide, and New York City is the largest single market for both areas. Imports from Bermuda are yet relatively unimportant but have been increasing during the past few years (charts 16 to 20, inclusive).

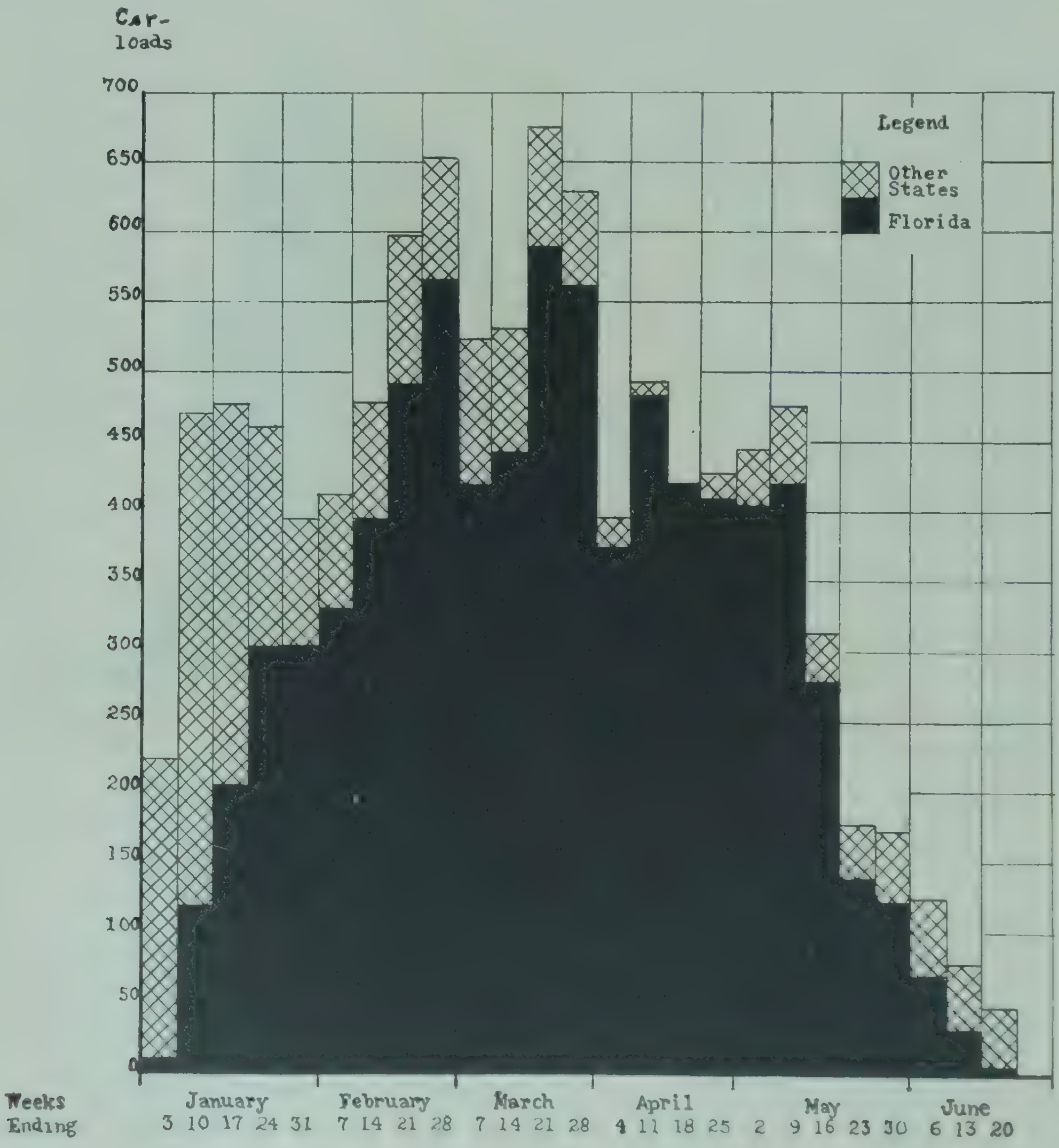

Chart 16.—Weekly car-lot shipments of celery from Florida and total competition from other states, 1925.

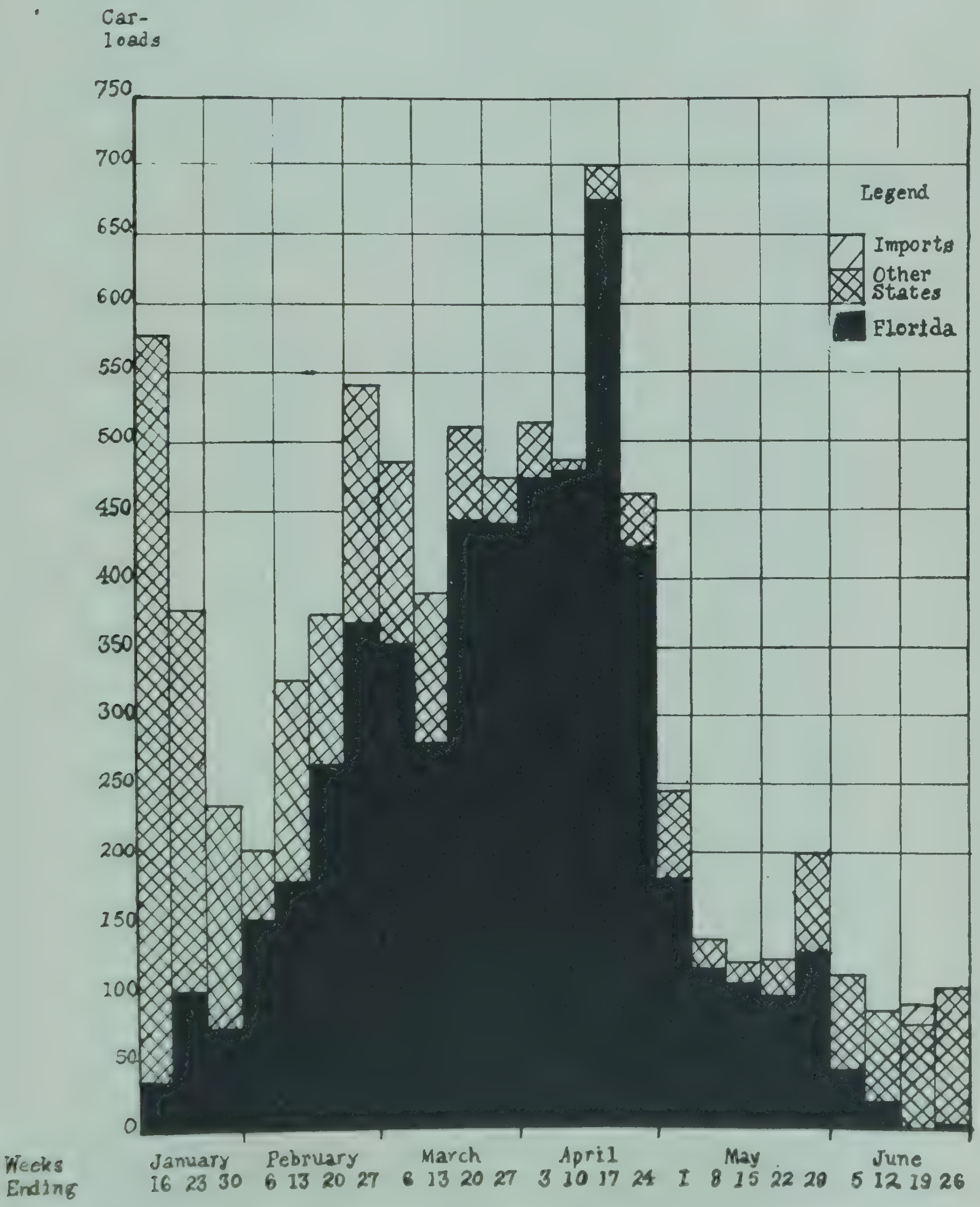

Chart 17.—Weekly car-lot shipments of celery from Florida and total competition from other states and imports, 1926.

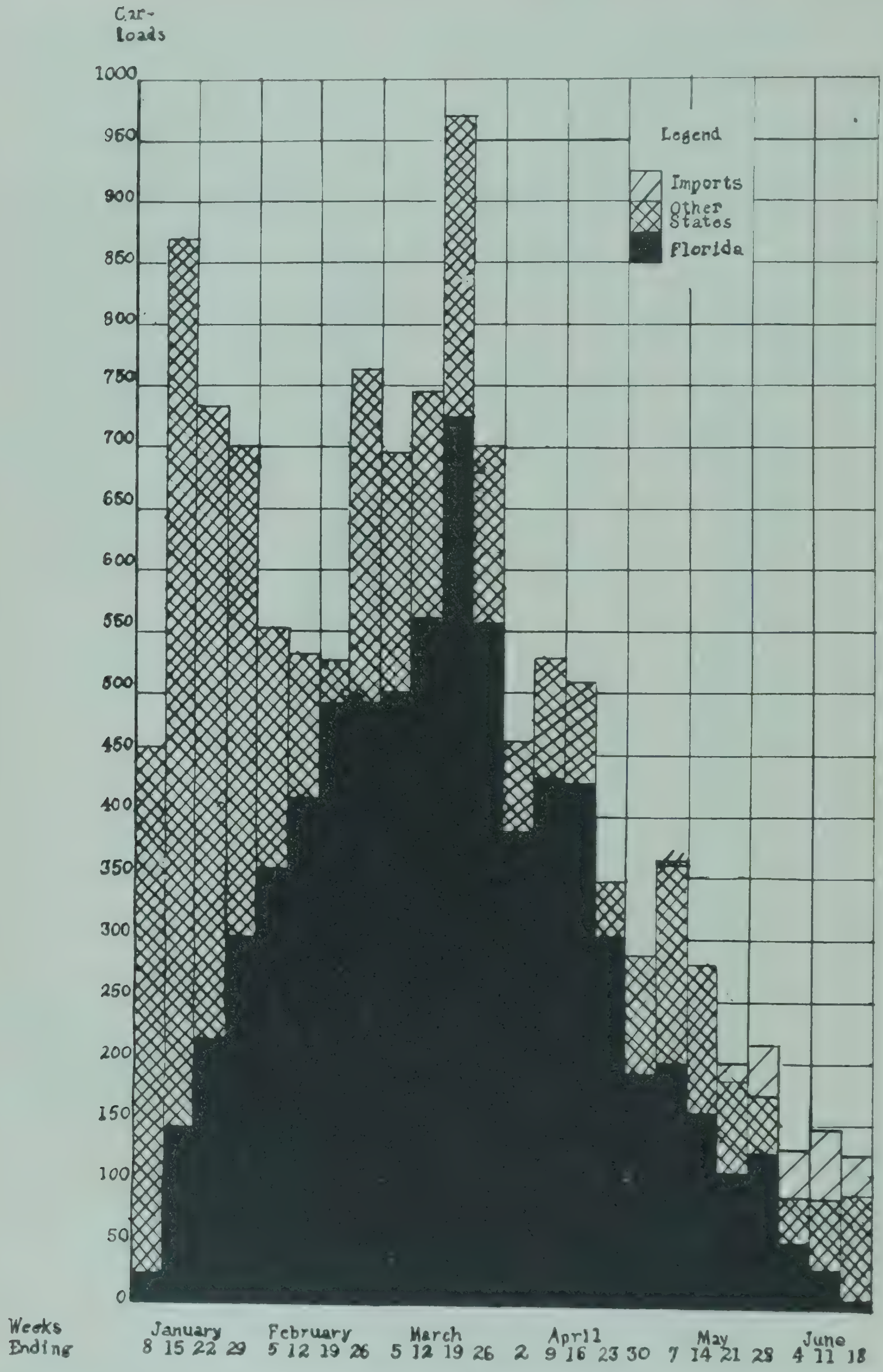

Chart 18.—Weekly car-lot shipments of celery from Florida and total competition from other states and imports, 1927.

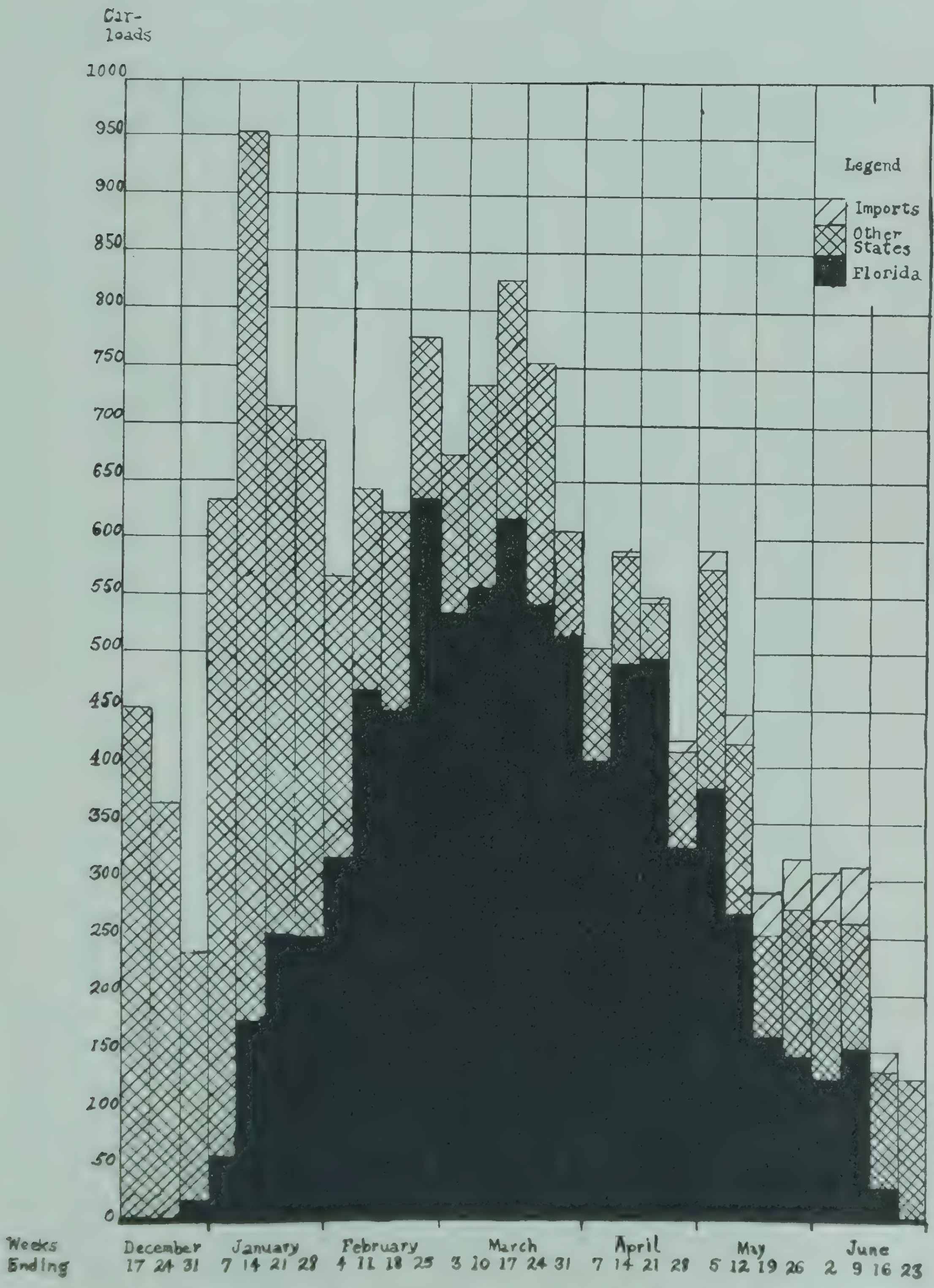

Chart 19.—Weekly car-lot shipments of celery from Florida and total competition from other states and imports, 1927-1928 season.

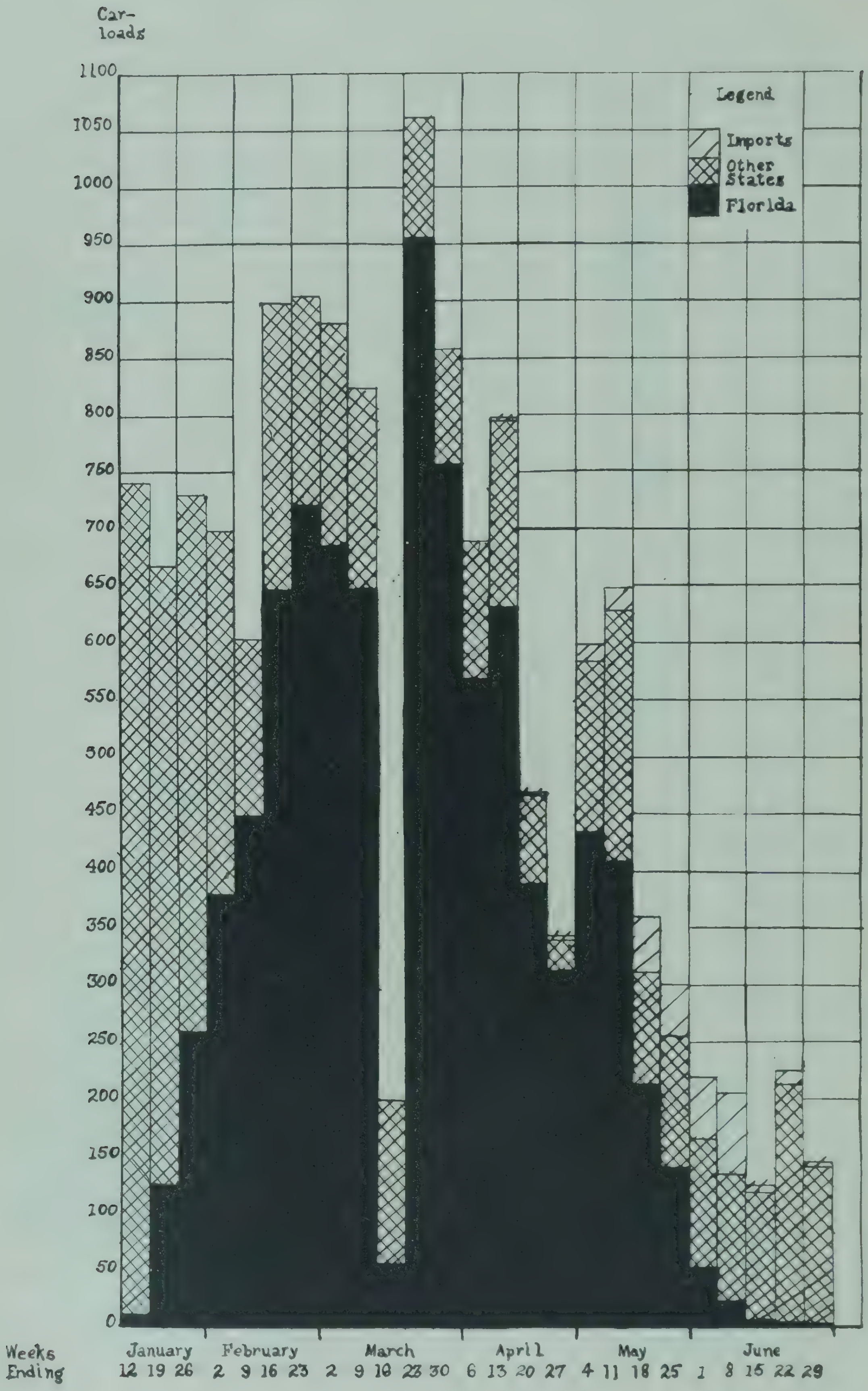

Chart 20.—Weekly car-lot shipments of celery from Florida and total competition from other states and imports, 1929.

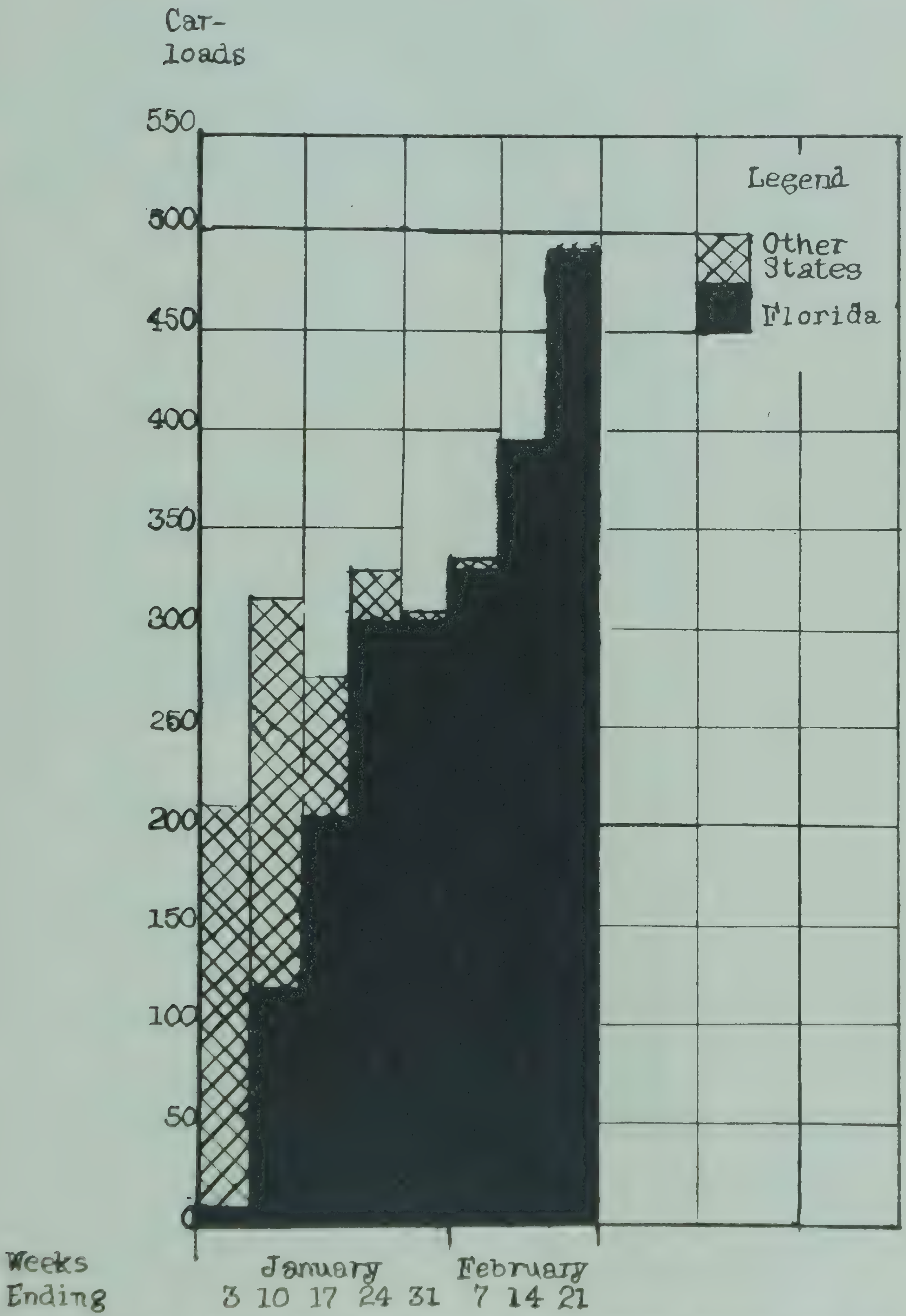

Chart 21.—Weekly car-lot shipments of celery from Florida with total stored celery competition from other states, 1925.

Celery is one of the Florida crops that must compete with supplies in storage, but for only a part of the season. New York is the principal source of this stored celery but there is also some marketed from Michigan and other northern states at this time of the year. There is competition from stored celery only at the beginning of the Florida season and it usually lasts little more than a month (charts 21 to 25 and Appendix Tables XIII to XVII, inclusive).

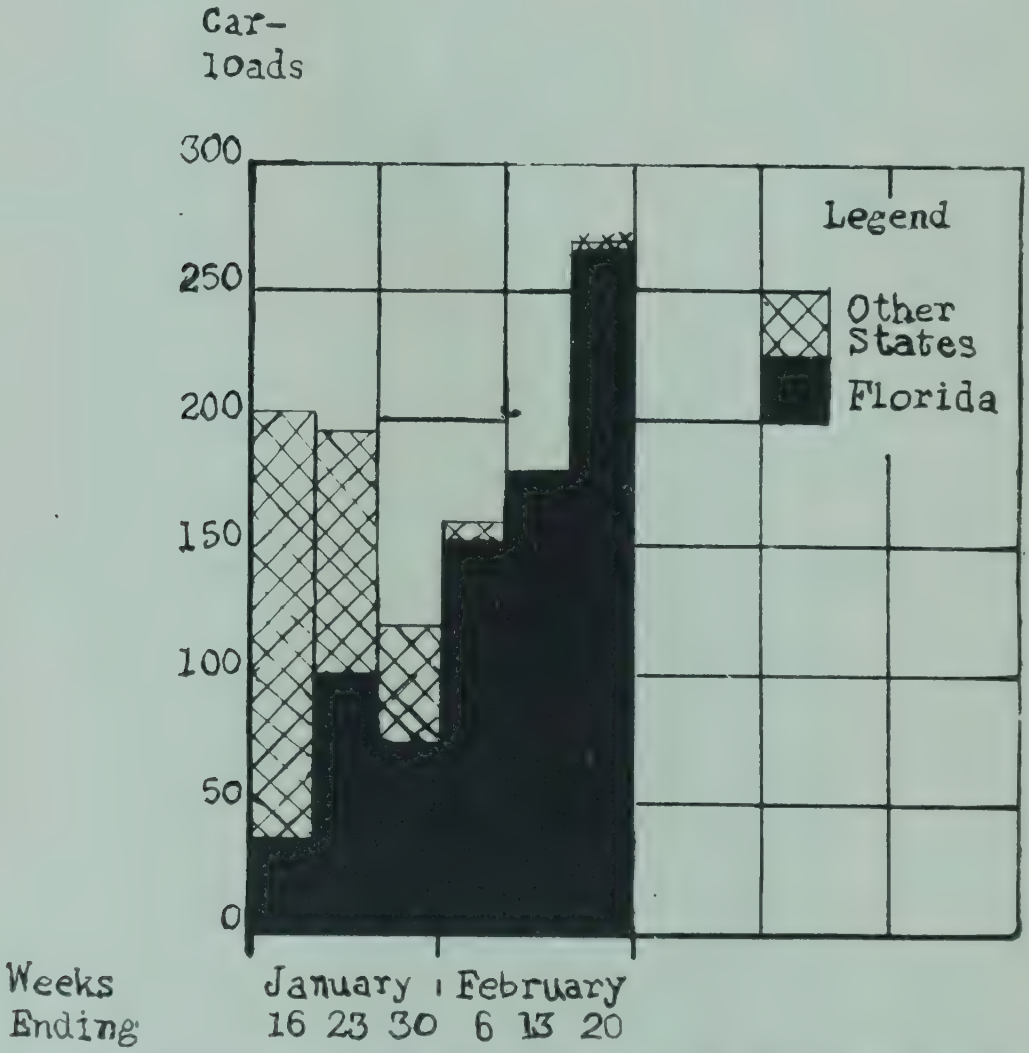

Chart 22.—Weekly car-lot shipments of celery from Florida with total stored celery competition from other states, 1926.

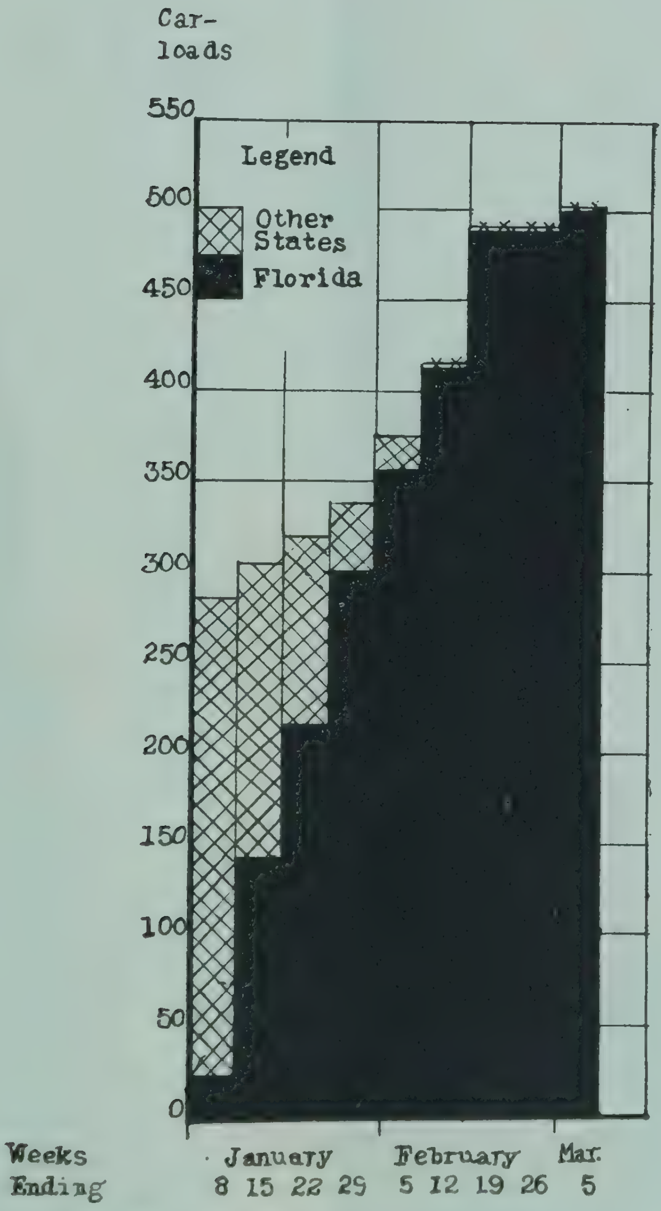

Chart 23.—Weekly car-lot shipments of celery from Florida with total stored celery competition from other states, 1927.

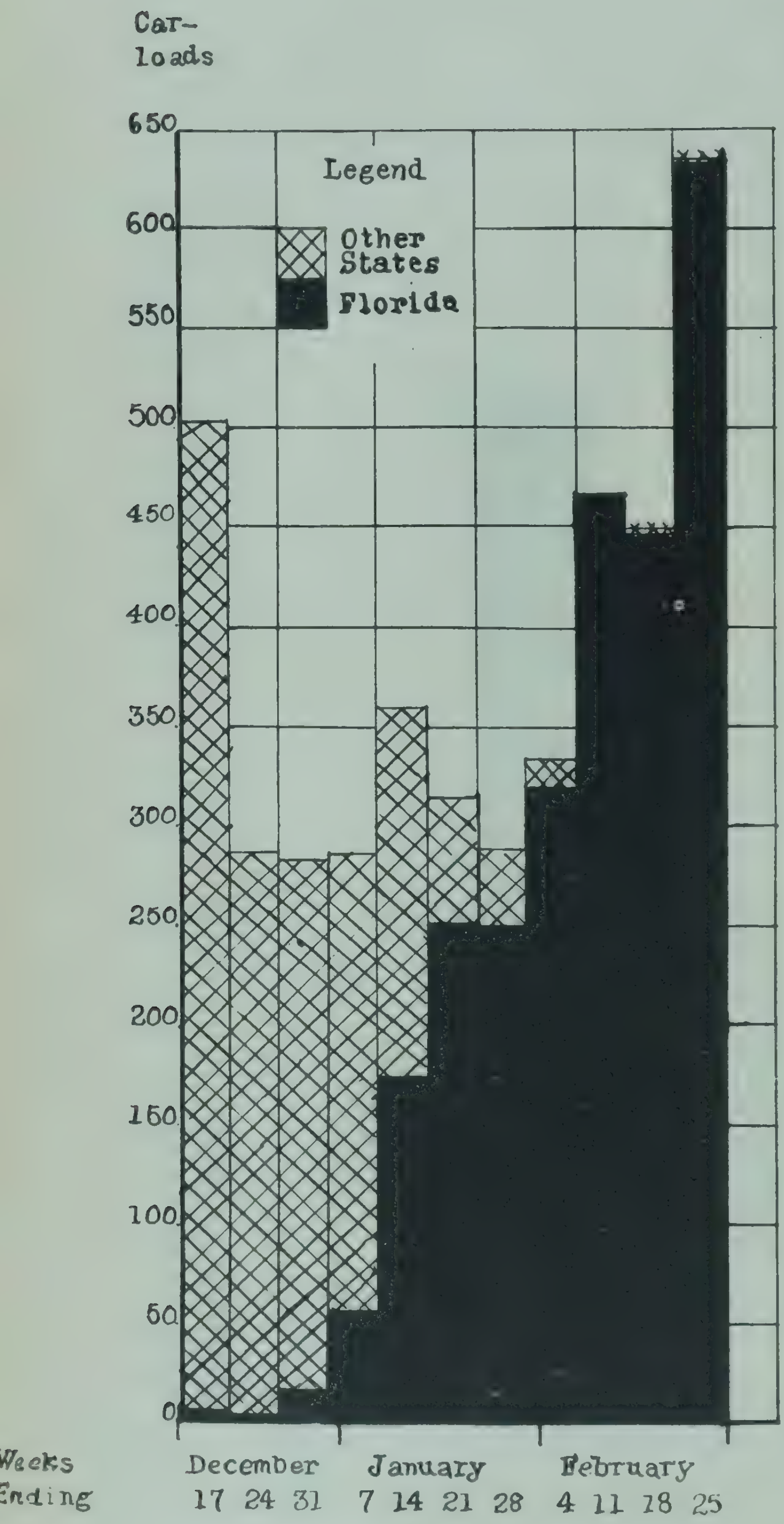

Chart 24.—Weekly car-lot shipments of celery from Florida with total stored celery competition from other states, 1927-1928 season.

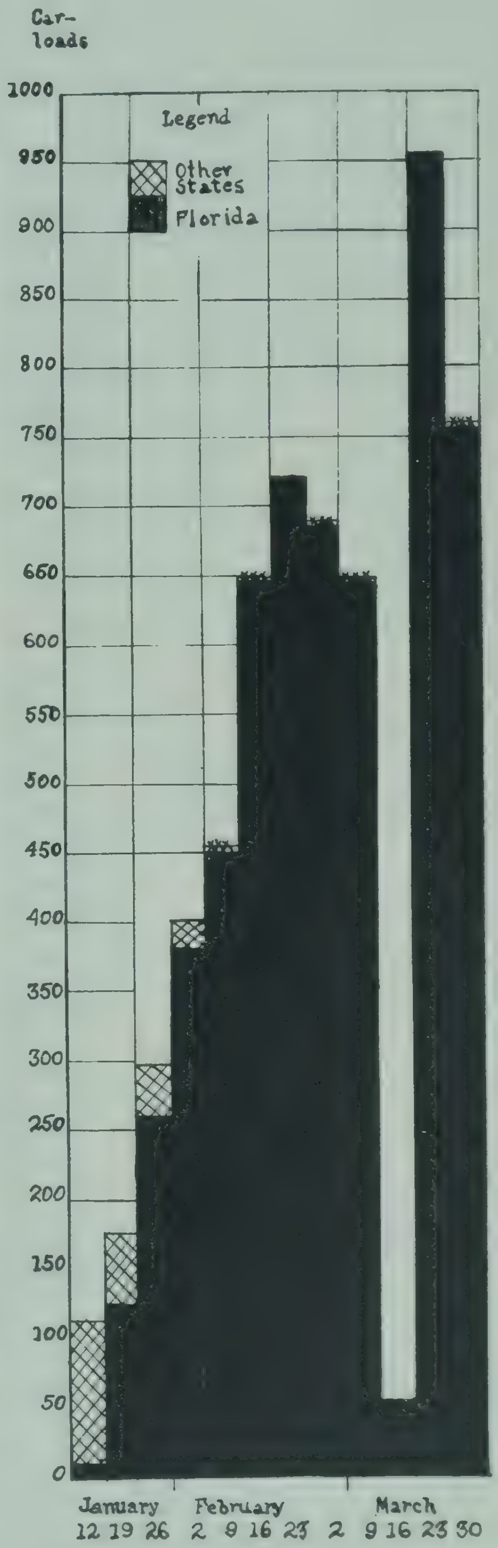

Chart 25.—Weekly car-lot shipments of celery from Florida with total stored celery competition from other states, 1929.

Celery production has increased in Florida from 4,686 carloads in 1922 to 8,871 carloads in 1929. It is evident that the greatest competition which Florida producers meet is among themselves.

CUCUMBERS

Cucumbers move in small quantities from south Florida during the fall and early winter, but most of the cars move out during the spring months. California moves a few cars in competition with the Florida fall crop, but neither state ships appreciable quantities at this season of the year.

Illinois, Indiana, and Ohio produce hot-house cucumbers for market throughout the spring season when Florida's main crop is being marketed.

The Florida shipping season normally opens about March 20 with shipments from the southern part of the state, followed closely by shipments of trough-protected cucumbers from Sumter County and then by open field crops from sections farther northward in the state. While there are some shipments from a number of states, real competition does not start until Texas begins shipping in volume about the first of May, followed closely by Alabama and South Carolina. Imports are negligible but have increased somewhat and come in during the early part of the Florida season. Cuba is the principal source. In point of volume Florida ships almost twice as many cucumbers as any other state, and about one-fourth of the total car-lot shipments of the United States (charts 26 to 30 and Appendix Tables XIX to XXIII, inclusive).

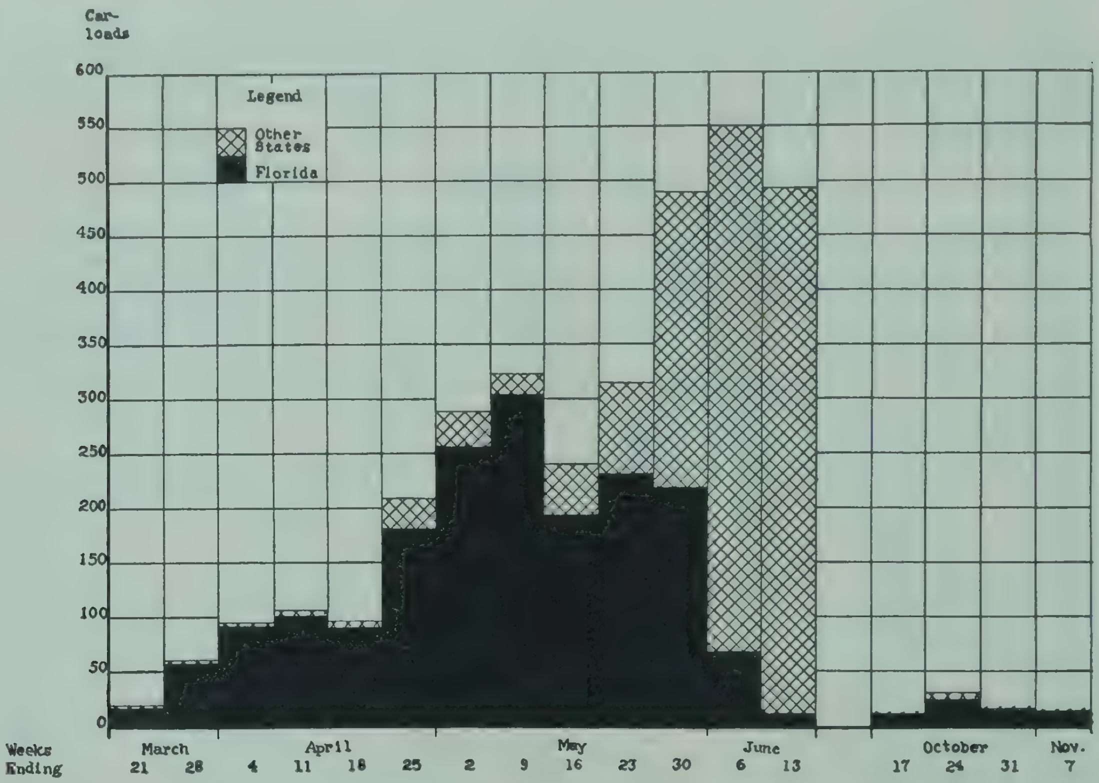

Chart 26.—Weekly car-lot shipments of cucumbers from Florida and total competition from other states, 1925.

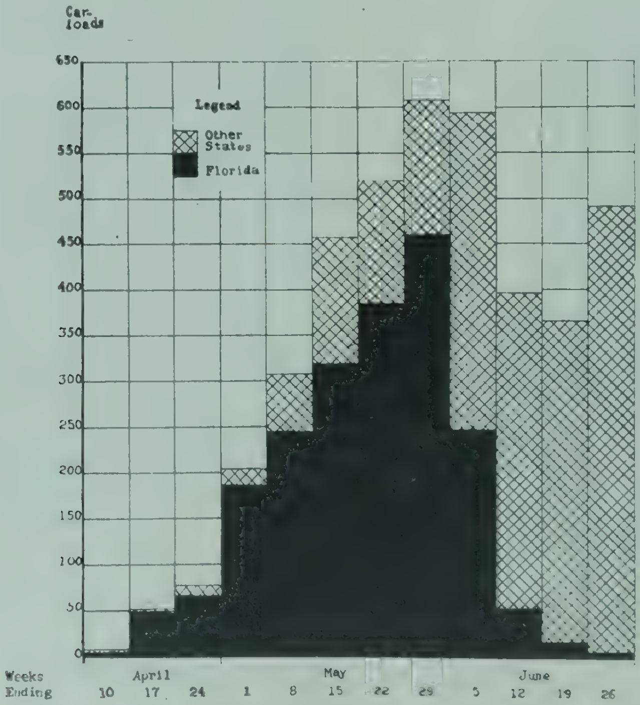

Chart 27.—Weekly car-lot shipments of cucumbers from Florida and total competition from other states, 1926.

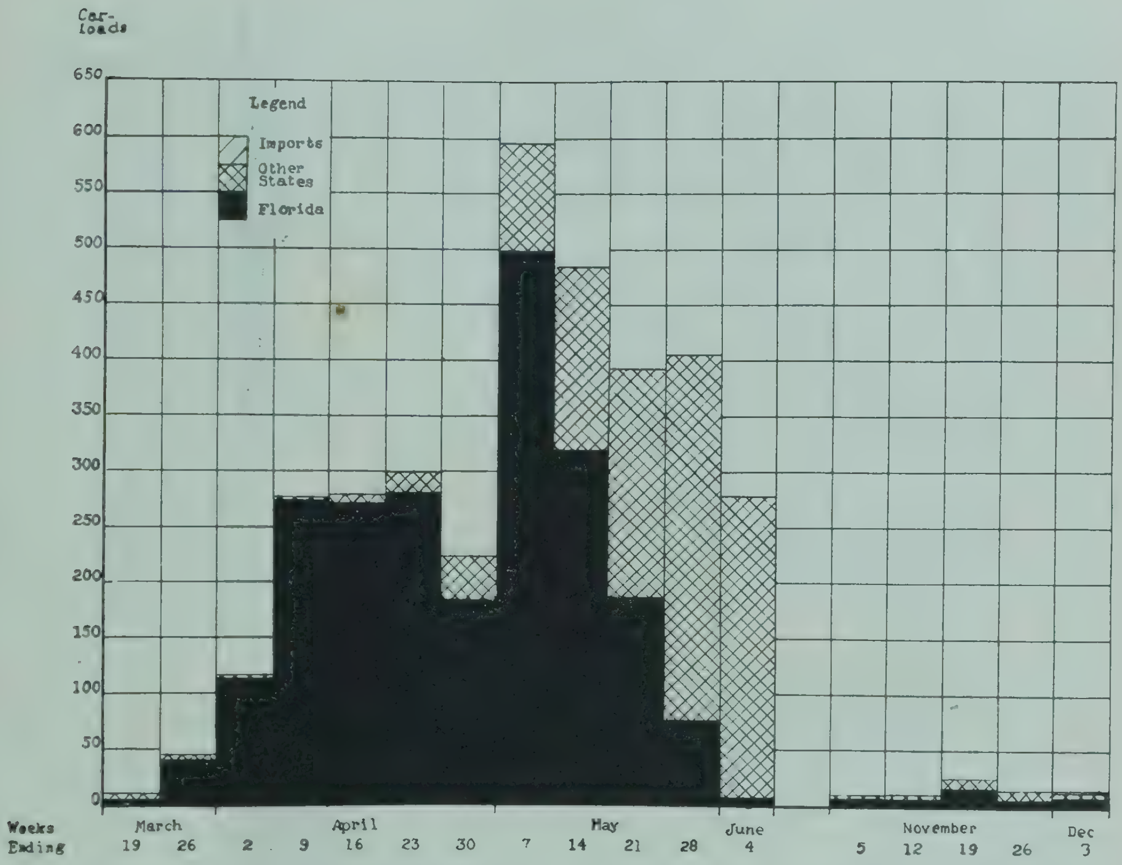

Chart 28.—Weekly car-lot shipments of cucumbers from Florida and total competition from other states, 1927.

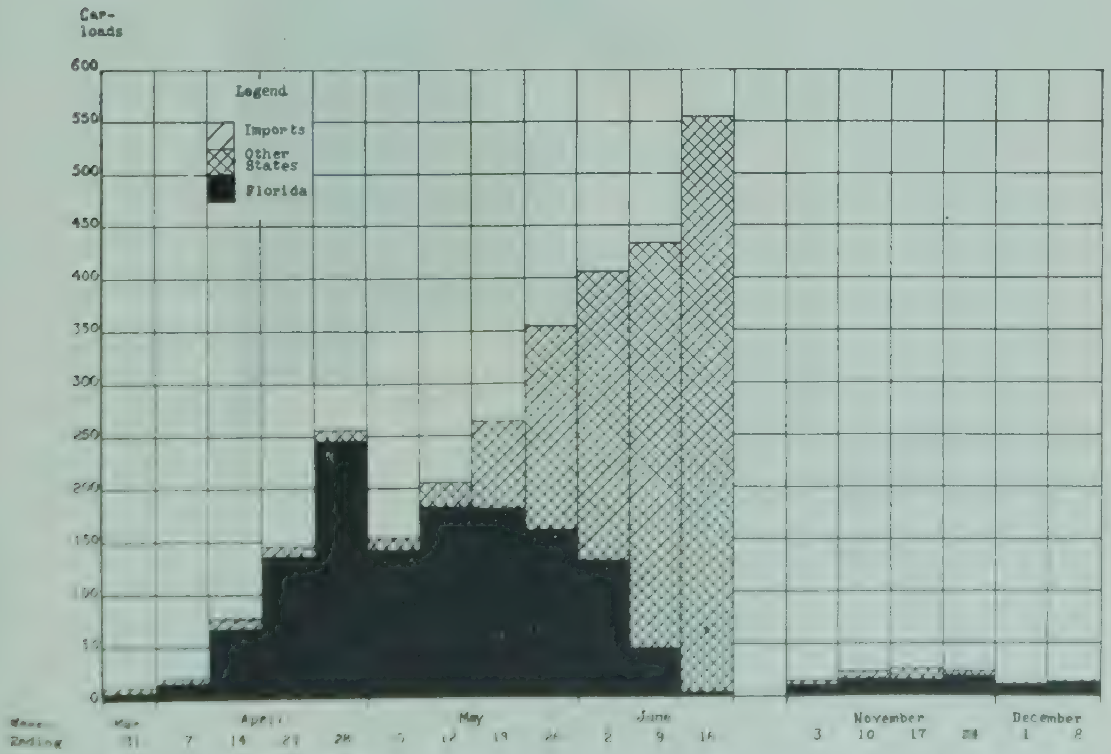

Chart 29.—Weekly car-lot shipments of cucumbers from Florida and total competition from other states and imports, 1928.

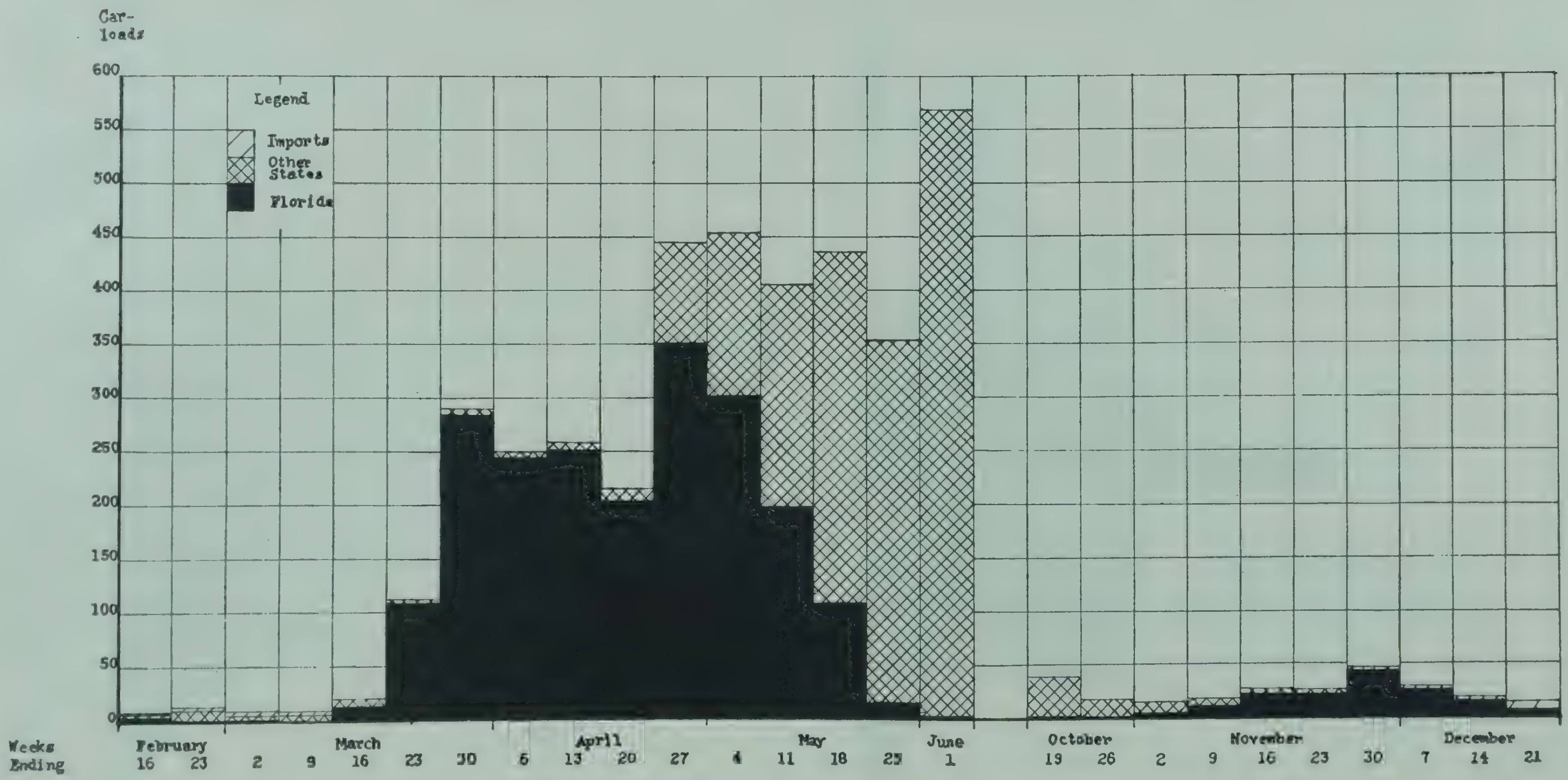

Chart 30.—Weekly car-lot shipments of cucumbers from Florida and total competition from other states and imports, 1929.

EGGPLANTS

Florida normally produces a spring and a fall crop of eggplants which, together, are being shipped in car-lots for approximately eight months of the year. The spring crop usually begins moving late in March and continues until mid-summer, while the fall shipments begin in October and continue until January 15 or February 1.

The Florida product experiences little competition from other states at any time of the year. Shipments from Virginia are relatively heavy beginning about July 1, but the Florida season is practically finished by that time. South Carolina, also, ships a few carloads during the summer. The fall crop meets some competition from Texas during November and December, but the weekly volume from that state does not at any time exceed the volume from Florida.

Imported eggplants constitute serious competition for shipments from Florida during the early spring. The strongest competition comes from Cuba, which country shipped a total of 223 carloads of eggplants into the United States during the spring of 1929, while Florida was shipping 194 carloads. Eggplants are being imported from Cuba when the Florida season opens in March, and continue to exceed shipments from Florida in weekly volume until about May 1. There are also light imports from Porto Rico and occasionally from Bermuda (charts 31 to 35 and Appendix Tables XXV to XXIX, inclusive).

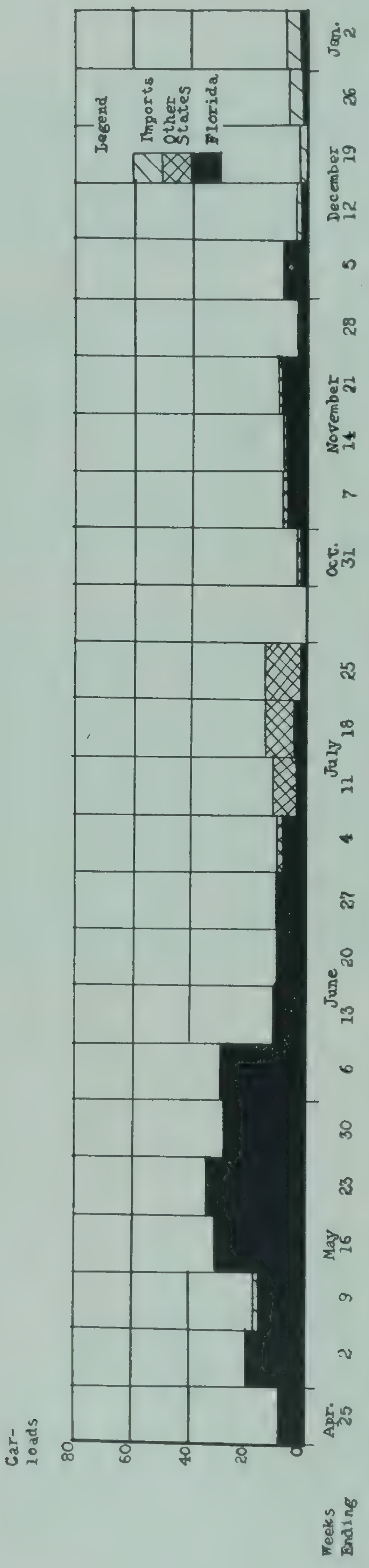

Chart 31.—Weekly car-lot shipments of eggplants from Florida and total competition from other states and imports, 1925-1926 season.

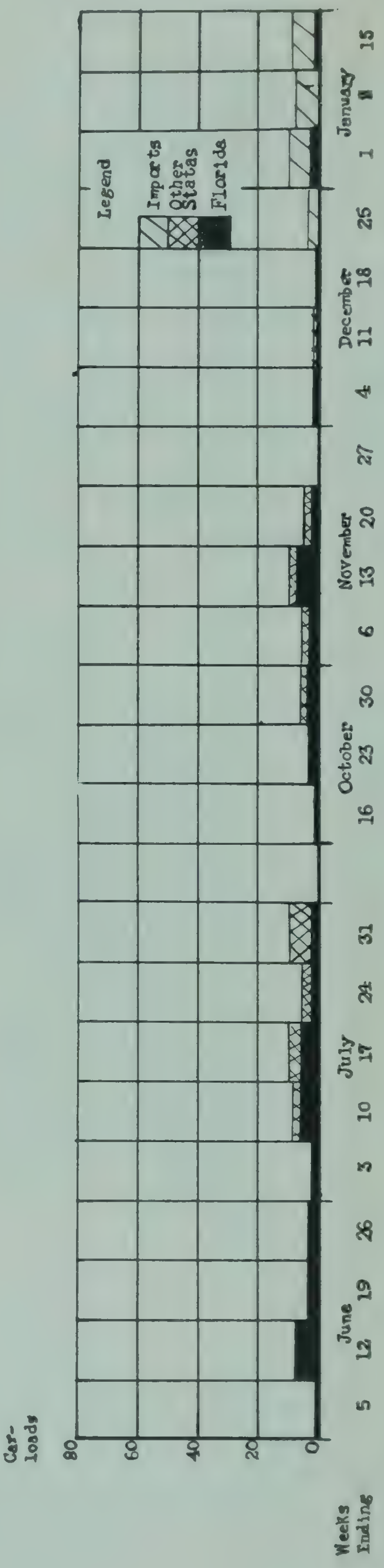

Chart 32.—Weekly car-lot shipments of eggplants from Florida and total competition from other states and imports, 1926-1927 season.

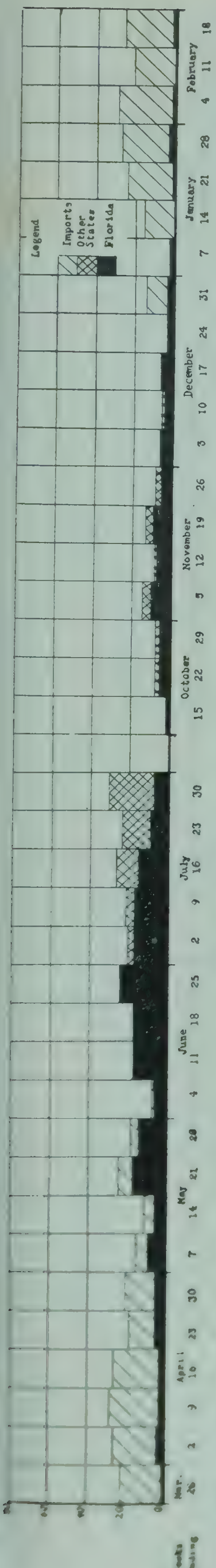

Chart 33.—Weekly car-lot shipments of eggplants from Florida and total competition from other states and imports, 1927-1928 season.

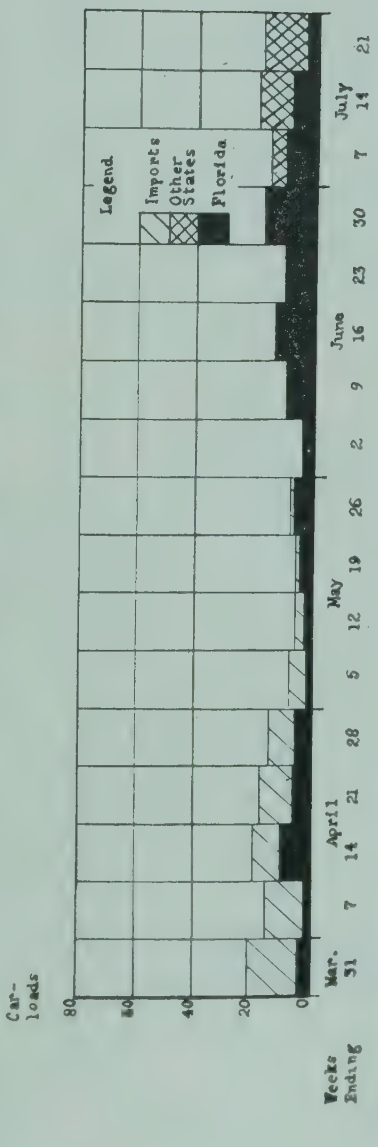

Chart 34.—Weekly car-lot shipments of eggplants from Florida and total competition from other states and imports, 1928.

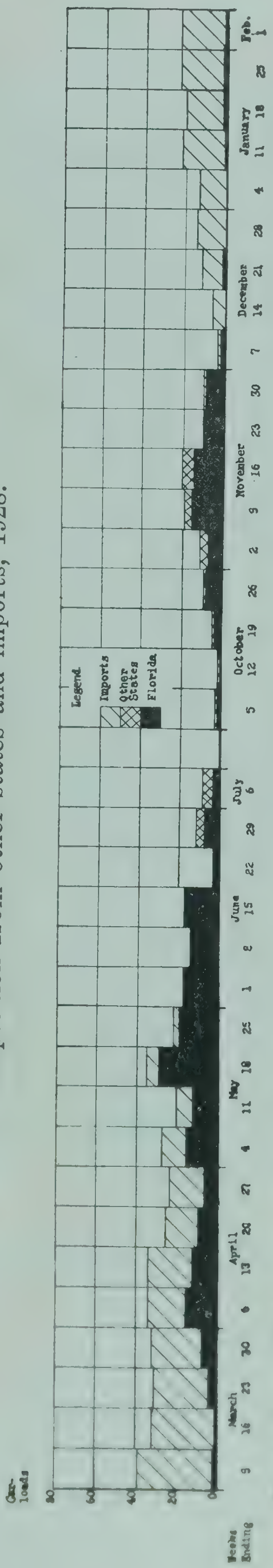

Chart 35.—Weekly car-lot shipments of eggplants from Florida and total competition from other states and imports, 1929-1930 season.

LETTUCE

Lettuce is now of minor importance in Florida as compared with a few years ago. The same is true of practically all states which produce the Butterhead type of lettuce. On the other hand shipments from the west have increased steadily and at a rapid rate. The ever-increasing popularity of the Iceberg type of lettuce grown in the West, together with a growing dissatisfaction for the Butterhead type grown in the East is the real reason for this change in the source of supply of lettuce.

During the 1928-29 season Florida shipped 1,108 carloads of lettuce, as against 2,633 carloads shipped during the 1921-22 season and 1,985 carloads during the 1924-25 season. Shipments from California during the Florida shipping season of 1928-29 totaled 15,416 carloads as against 6,592 carloads shipped in 1921-22 while the Florida crop was being marketed. Arizona, also, has been shipping large quantities of lettuce of the Iceberg type.

The Florida season opens about the middle of November and lasts five or six months, but the peak of the movement is in December and January. California and Arizona are shipping heavily throughout the Florida shipping season. When the Florida season opens there is still some late lettuce of the Butterhead type being marketed from New Jersey, and some Iceberg lettuce from Washington. Shipments from these sources soon end, however, and do not come in again during the Florida season. The chief competition in the East comes from South Carolina during the last few weeks of the Florida season (charts 36 to 40 and Appendix Tables XXXI to XXXV, inclusive).

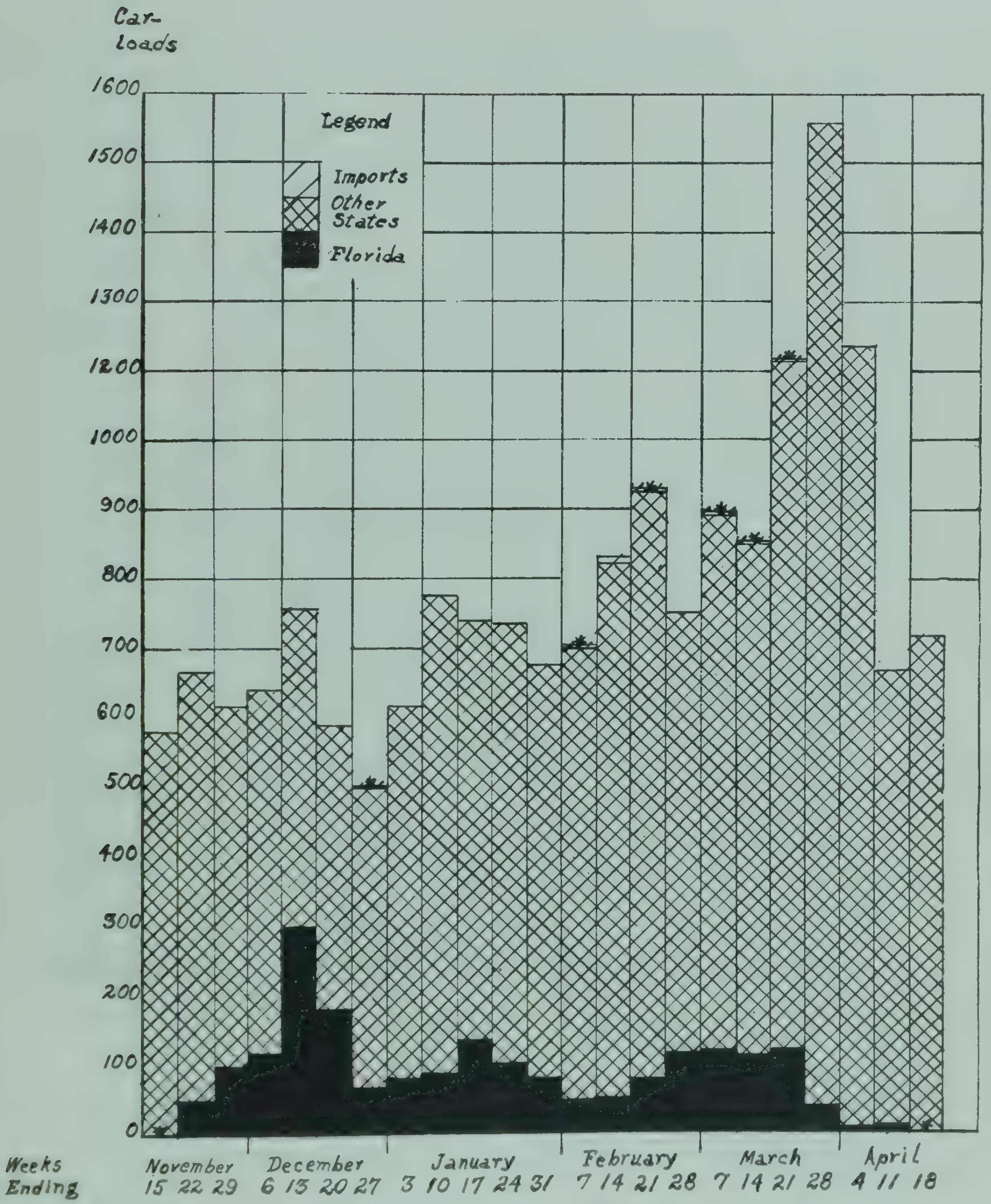

Chart 36.—Weekly car-lot shipments of lettuce from Florida and total competition from other states and imports, 1924-1925 season.

*Less than 5 carloads.

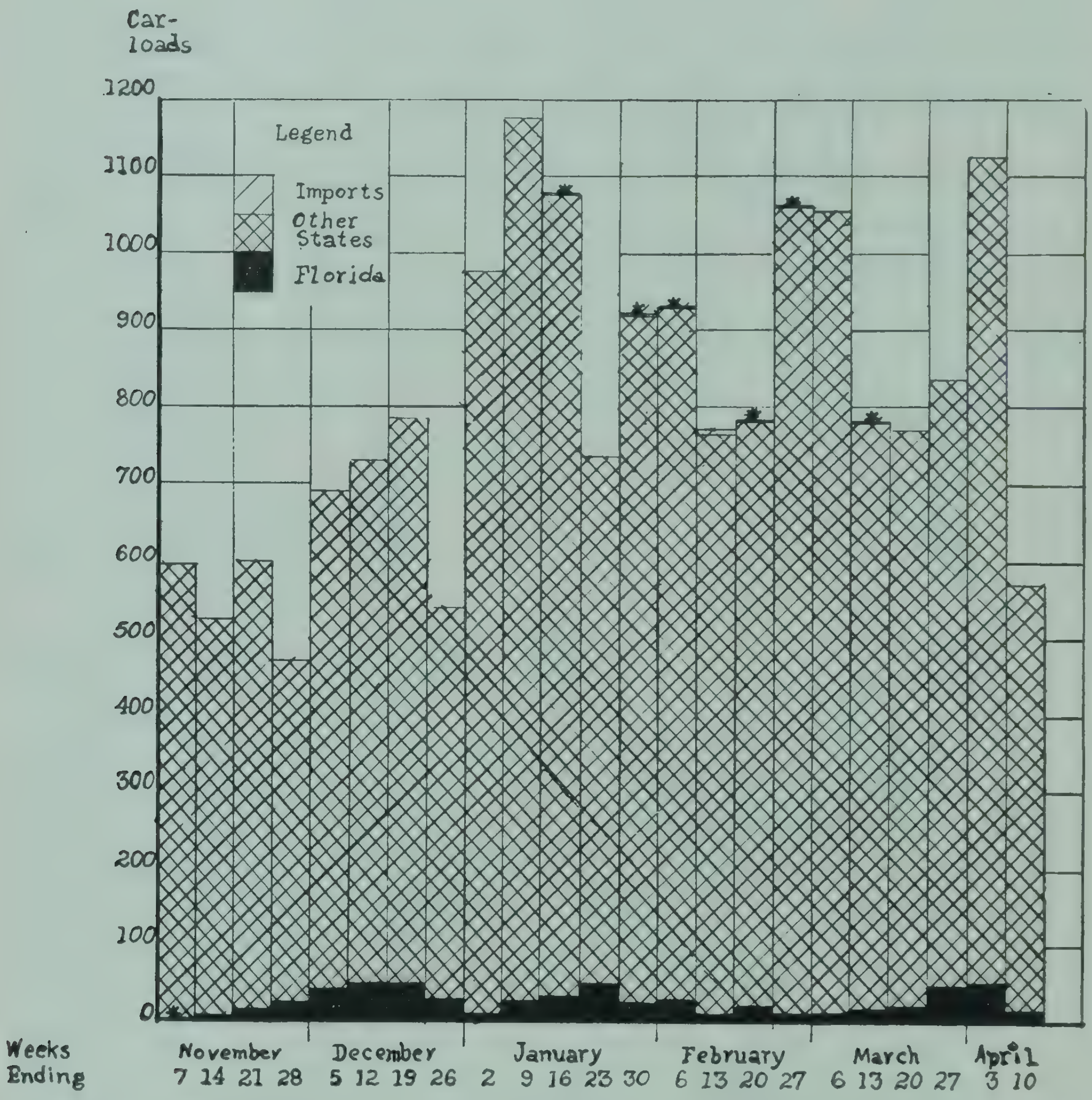

Chart 37.—Weekly car-lot shipments of lettuce from Florida and total competition from other states and imports, 1925-1926 season.
*Less than 5 carloads.

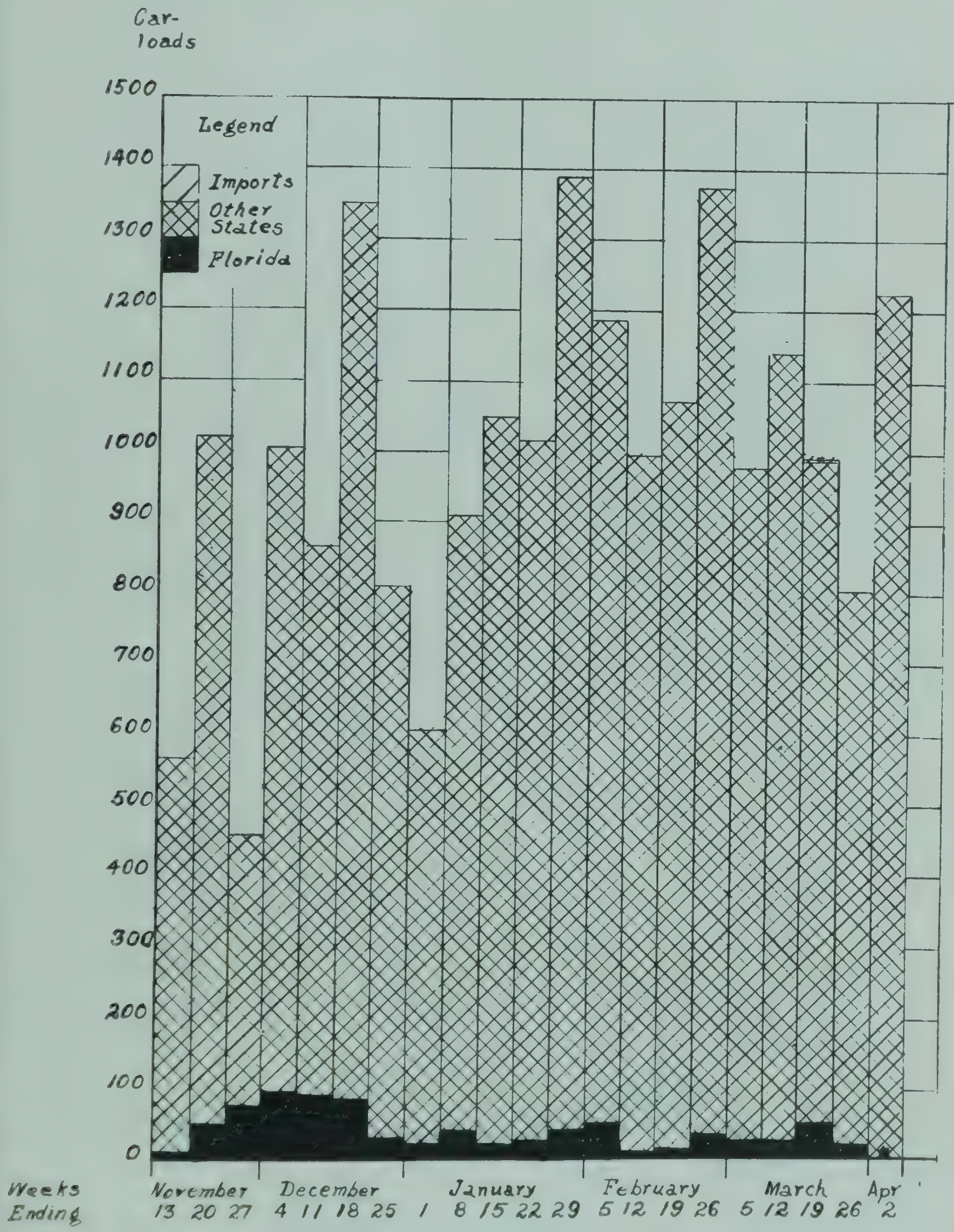

Chart 38.—Weekly car-lot shipments of lettuce from Florida and total competition from other states and imports, 1926-1927 season.
*Less than 5 carloads.

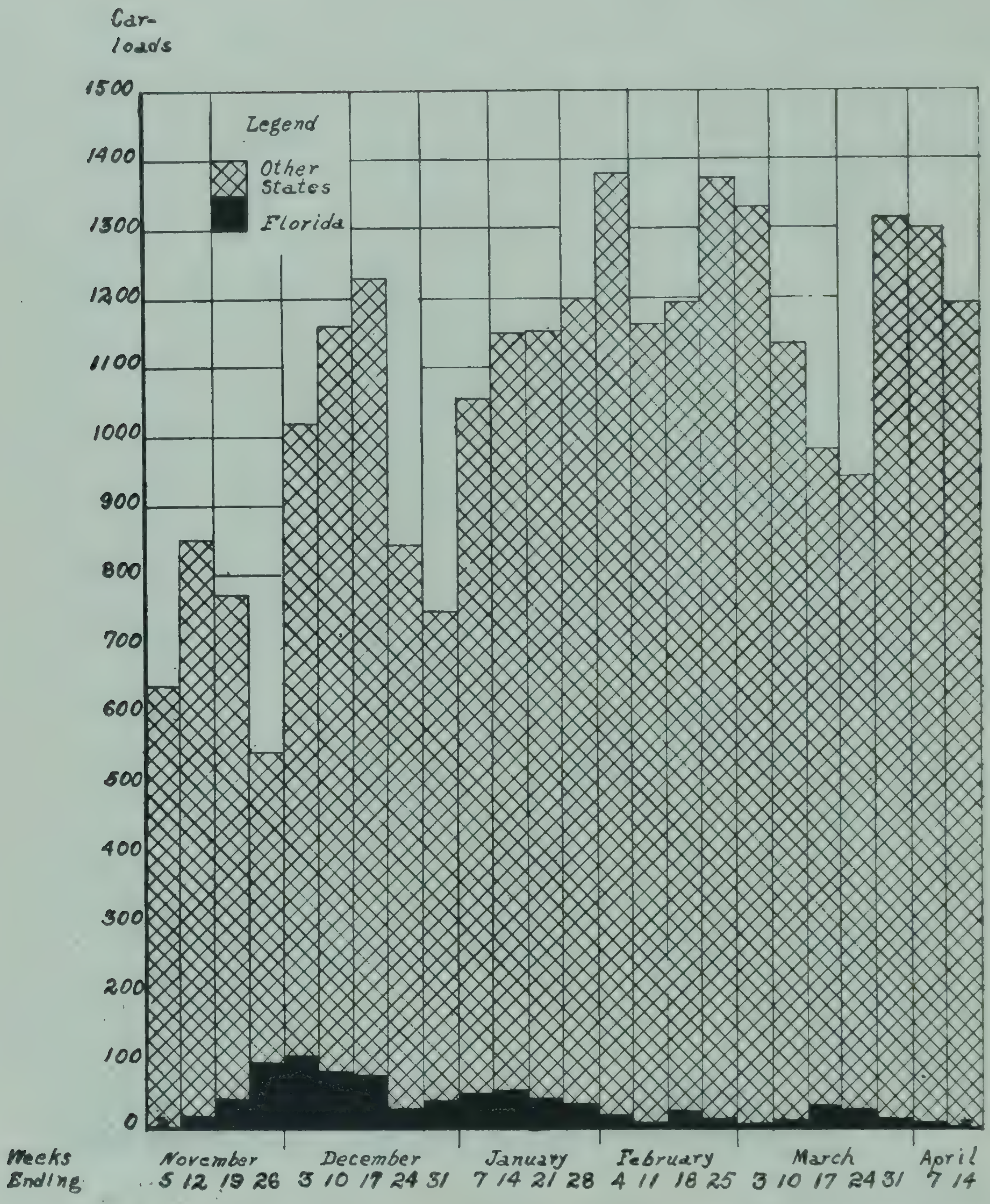

Chart 39.—Weekly car-lot shipments of lettuce from Florida and total competition from other states, 1927-1928 season.

*Less than 5 carloads.

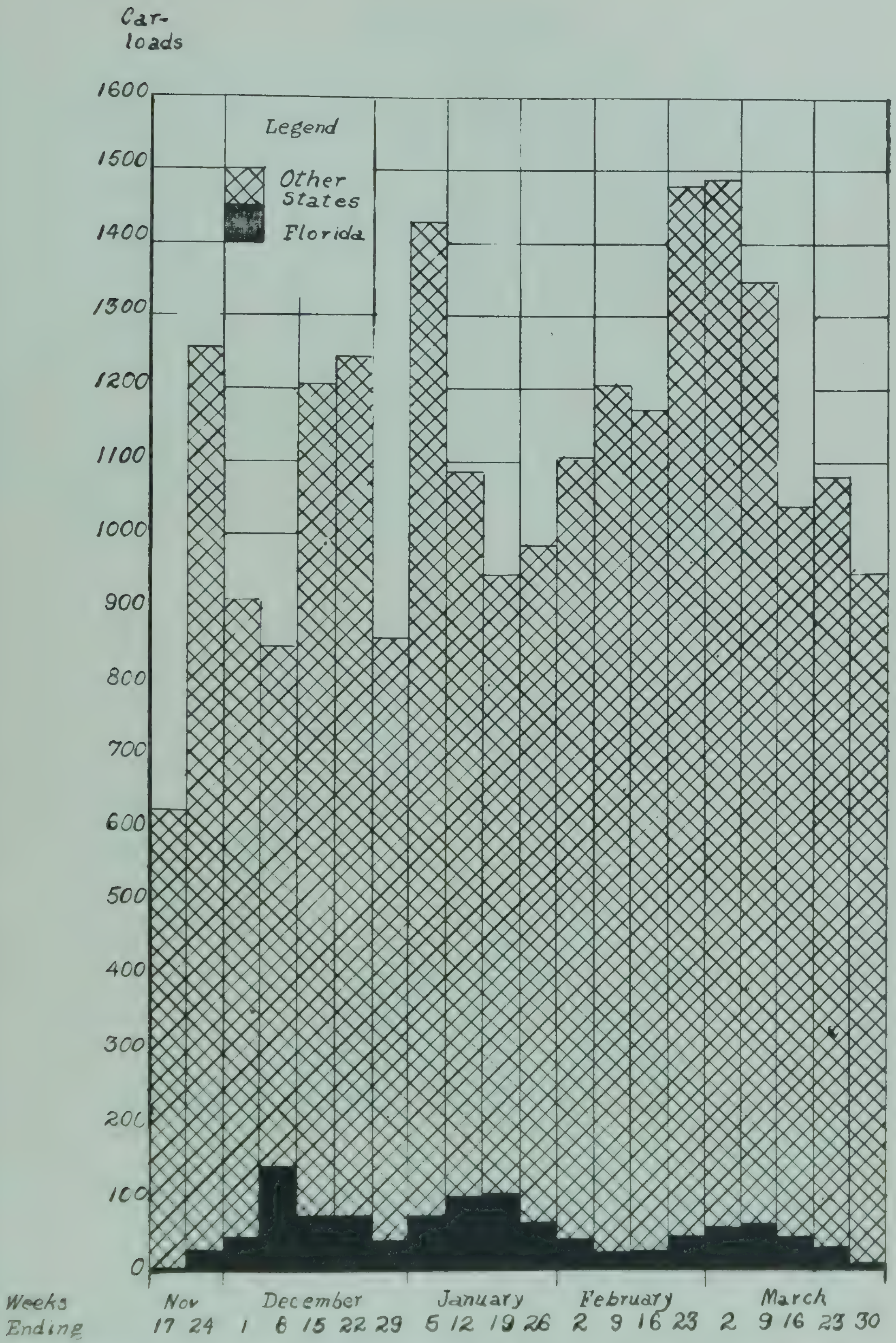

Chart 40.—Weekly car-lot shipments of lettuce from Florida and total competition from other states, 1928-1929 season.

GREEN PEAS

Florida ranks ninth among the states in average value of production of green peas (Table II). Shipments are light and irregular, but there are car-lot movements at intervals during some seasons from late November until March or April. The usual season is much shorter, however. During these months the markets of the United States are almost entirely dependent on southern California and Mexico for their supplies of green peas. Steadily increasing quantities have been imported from Mexico during the past few seasons. Practically all of these imports come in during the four months December to March. Shipments from California and an occasional car from Texas constitute the competition from other states during the winter months (charts 41 to 43 and Appendix Tables XXXVII to XXXIX, inclusive.

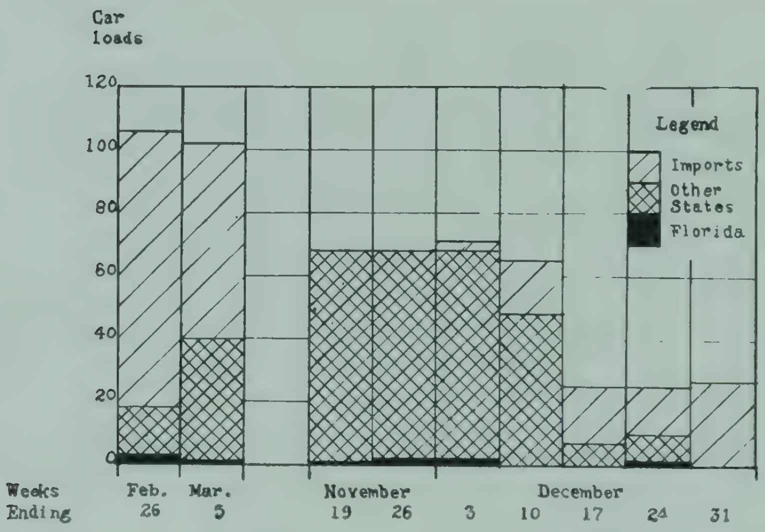

Chart 41.—Weekly car-lot shipments of green peas from Florida and total competition from other states and imports, 1927.

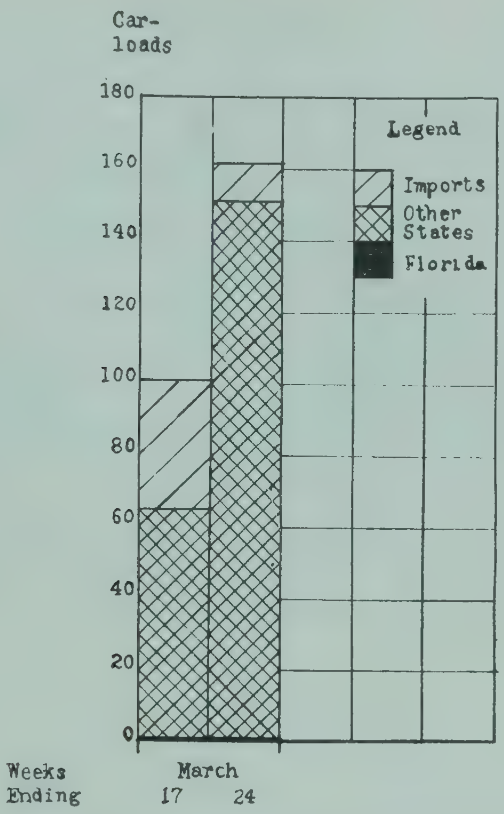

Chart 42.—Weekly car-lot shipments of green peas from Florida and total competition from other states and imports, 1928.

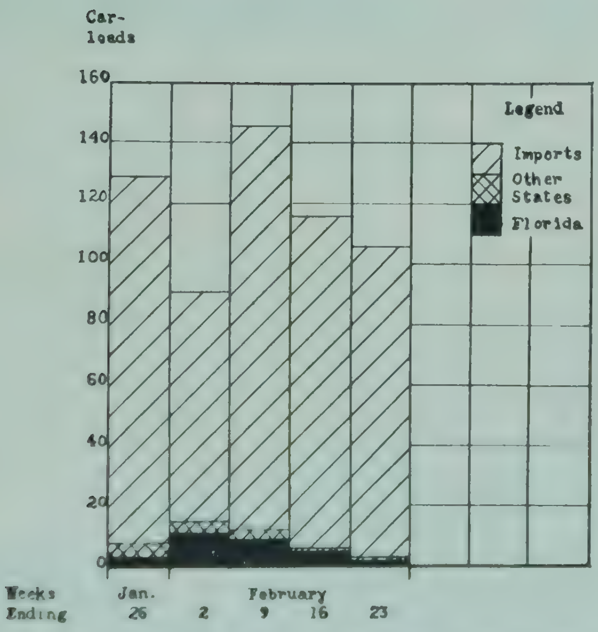

Chart 43.—Weekly car-lot shipments of green peas from Florida and total competition from other states and imports, 1929.

PEPPERS

Florida ranks first in the production of peppers with no close competitor. For the past few seasons Florida has shipped almost 50 percent of the United States total. The Florida shipping season opens about the first of November and remains open until mid-summer the following year. There is little competition from other states until about the first of June when Louisiana begins shipping and soon assumes first place in weekly car-lot movement.

Fall peppers from Florida meet some competition from California, New Jersey, Texas, and other states until about the end of November. After that time Florida producers have a clear field, except for imports, until the spring movement from other states (charts 44 to 48 and Appendix Tables XLI to XLV, inclusive).

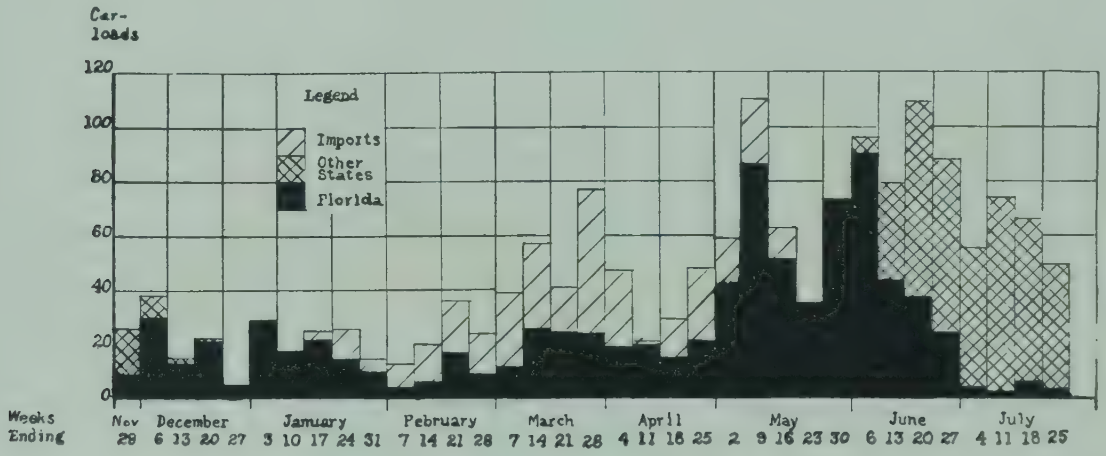

Chart 44.—Weekly car-lot shipments of peppers from Florida and total competition from other states and imports, 1924-1925 season.

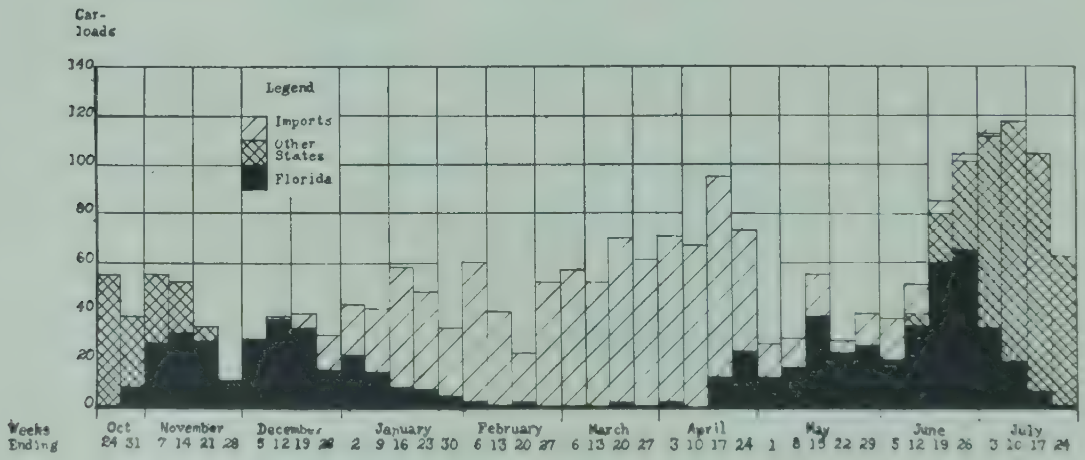

Chart 45.—Weekly car-lot shipments of peppers from Florida and total competition from other states and imports, 1925-1926 season.

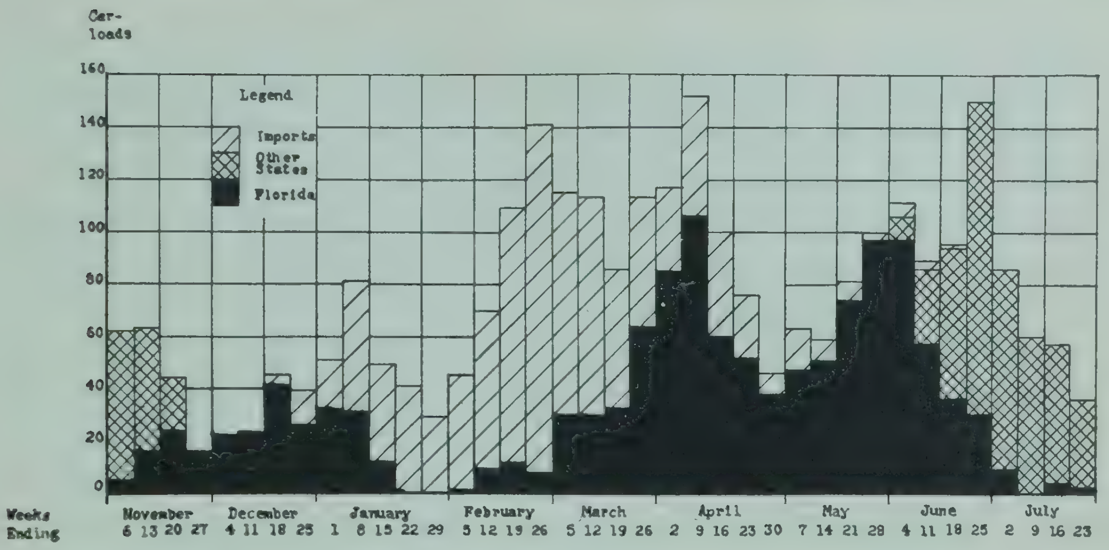

Chart 46.—Weekly car-lot shipments of peppers from Florida and total competition from other states and imports, 1926-1927 season.

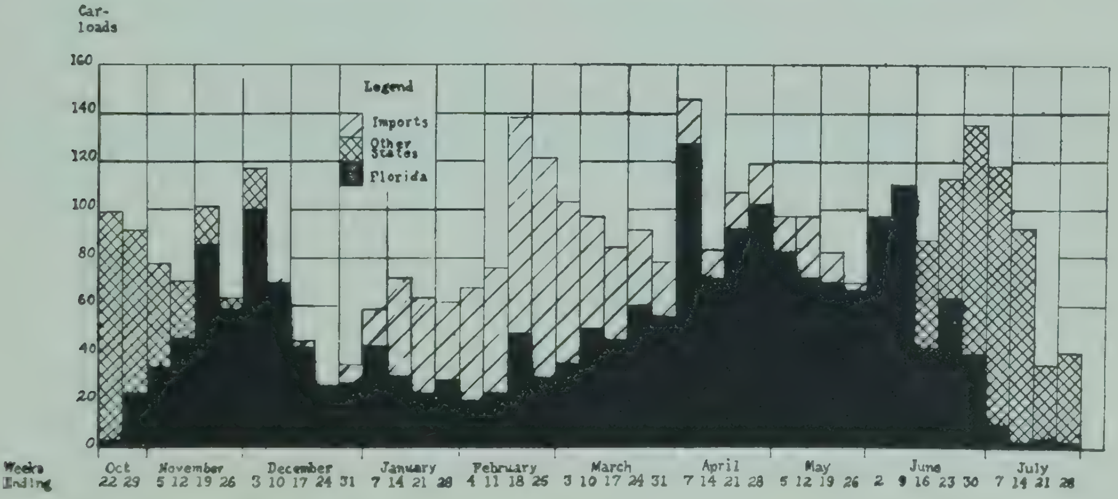

Chart 47.—Weekly car-lot shipments of peppers from Florida and total competition from other states and imports, 1927-1928 season.

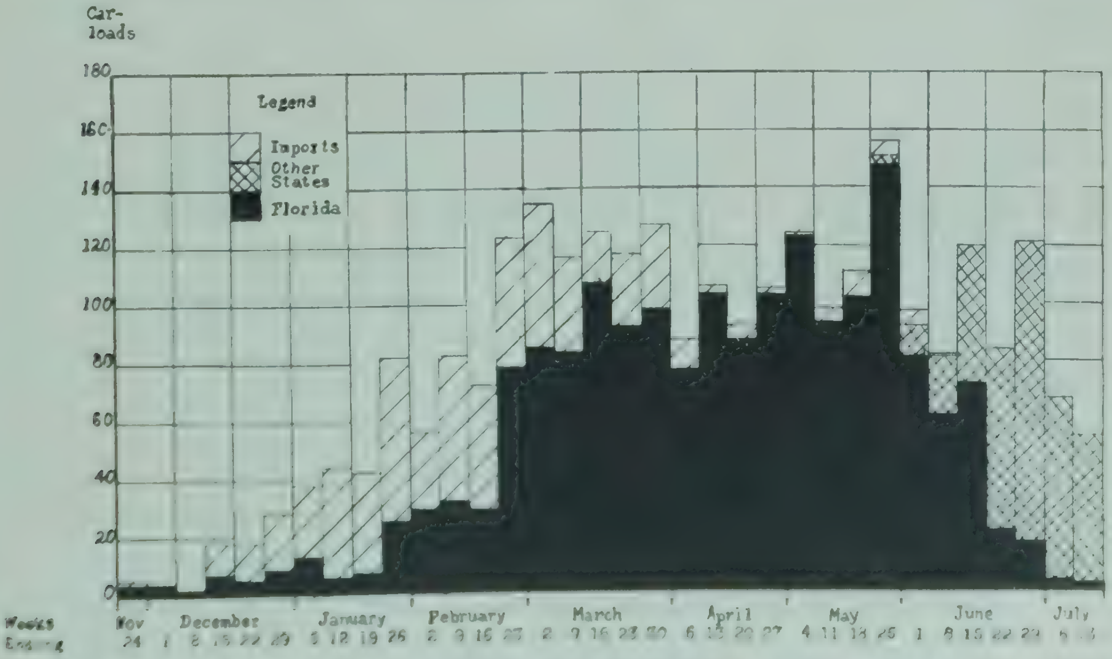

Chart 48.—Weekly car-lot shipments of peppers from Florida and total competition from other states and imports, 1928-1929 season.

Imported peppers furnish real competition for the Florida product during the period from December to May. Mexico and Cuba are the principal sources of these imports. The total movement from Florida is considerably greater than imports from all sources combined, but imports exceed shipments from Florida in weekly volume during January and February, and are heavy during March and April. Imports were greatly encouraged by the usual light shipments from Florida during January and February which were made still lighter by the fall storms of 1926 and 1928, when much of the fall planted acreage of peppers in Florida was destroyed. From January 15 to February 5, 1927, only one car of peppers moved from Florida and shipments continued light during February, thus causing an increase the next season in both Florida and foreign plantings. The trends of shipments from Florida and imports of peppers are indicated in Table V.

TABLE V.—CAR-LOT SHIPMENTS OF PEPPERS FROM FLORIDA AND IMPORTS, 1924-25 TO 1928-29.

Season	Mexico	Cuba	Other	Total Imports	Florida
1924-25	......	309	18	327	865
1925-26	174	776	....	950	694
1926-27	392	578	21	991	1,280
1927-28	442	308	....	750	2,049
1928-29	289	276	....	565	1,811

EARLY WHITE POTATOES

White potatoes are exceeded only by tomatoes in importance as a Florida truck crop, when considered on the basis of value. While white potatoes are very widely distributed in the United States, the Florida potato area is probably more localized than that of any other important crop of this state, with the city of Hastings located well in the heart of the area. A few carloads are shipped from points in the southern parts of the state in January, February, and early March, but it is not until near the middle of March that the potato movement from this state assumes real importance. Texas is an active competitor on the early potato market during the greater part of the Florida shipping season. The volume is only about one-half as great as that shipped by Florida, however, and the principal markets are in the middle-west, whereas Florida ships principally to the eastern markets. Louisiana, Alabama, Mississippi, and South Carolina usually begin shipping at about the peak of the Florida season, and are followed shortly thereafter by Georgia, Arkansas, California, North Carolina, and Virginia. Aside from the Texas competition, the Carolinas, Alabama, and Virginia provide Florida's severest competition on the early potato market. The last named state, however, seldom starts shipping until the Florida season is practically ended. After about the middle of May competition with states farther north largely eliminates Florida from the markets of the country.

Imports of early potatoes are mostly confined to Bermuda and Cuba, and, while not large, are becoming of increasing importance. There are imports from Bermuda almost throughout the Florida season. The peak of the imports comes about the last of March, shortly before the peak of the Florida season. (charts 49 to 53, inclusive).

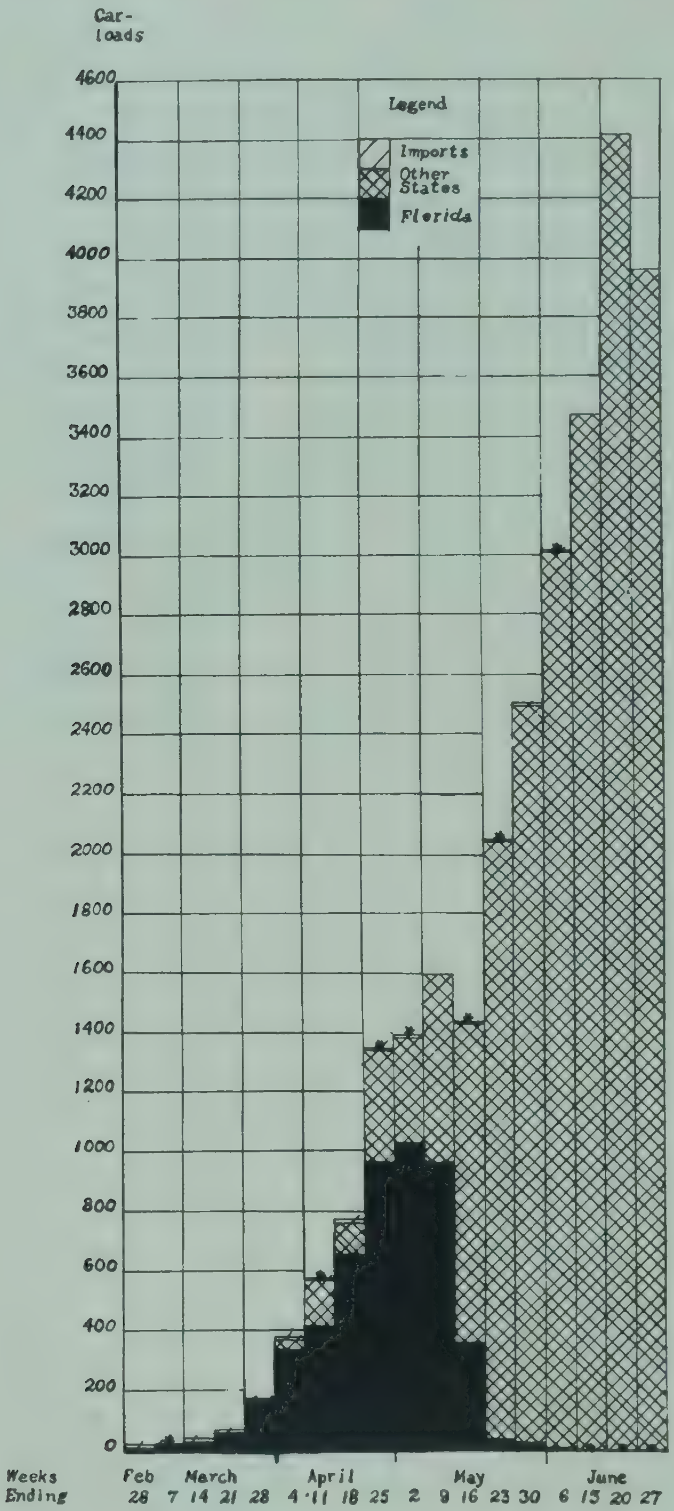

Chart 49.—Weekly car-lot shipments of white potatoes from Florida and total competition from other states and imports, 1925.

*Less than 5 carloads.

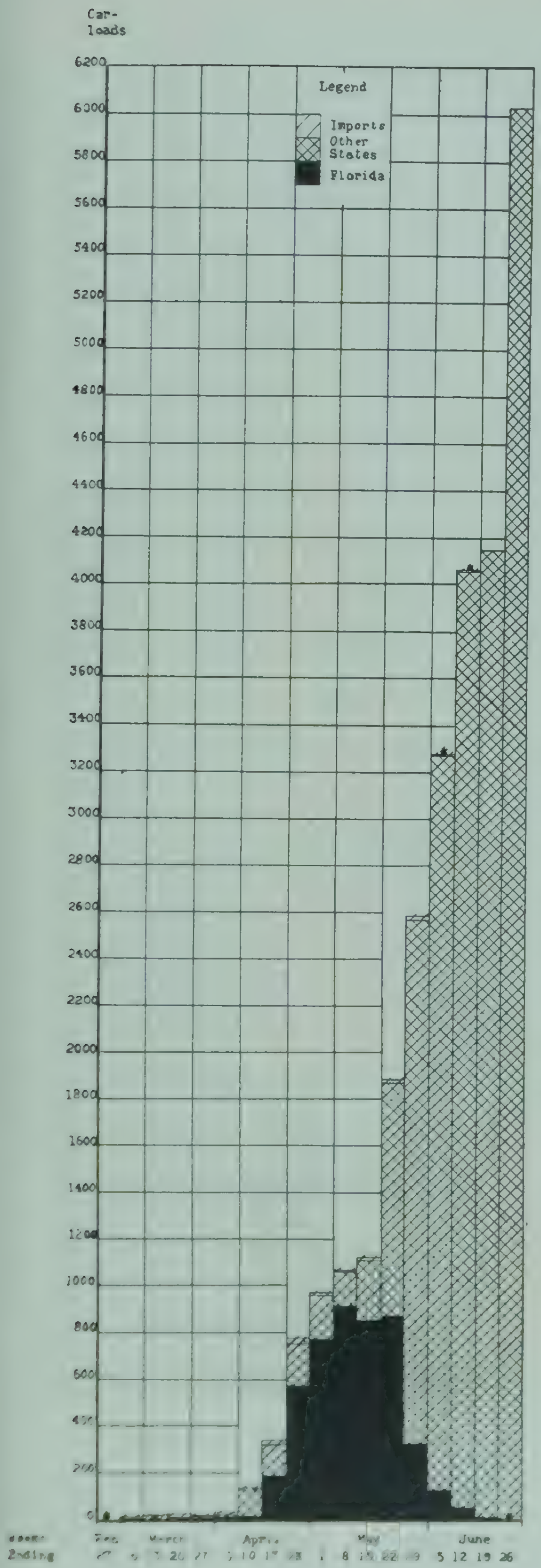

Chart 50. — Weekly car-lot shipments of white potatoes from Florida and total competition from other states and imports, 1926.

*Less than 5 carloads.

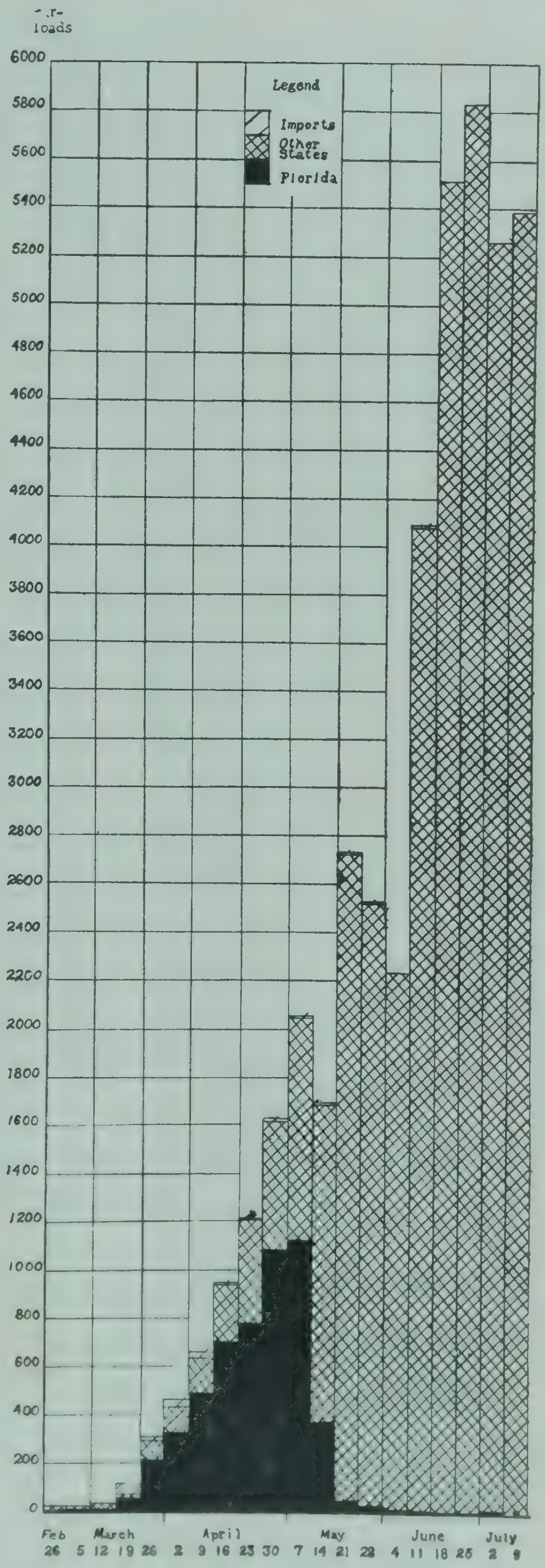

Chart 51.—Weekly car-lot shipments of white potatoes from Florida and total competition from other states and imports, 1927.

*Less than 5 carloads.

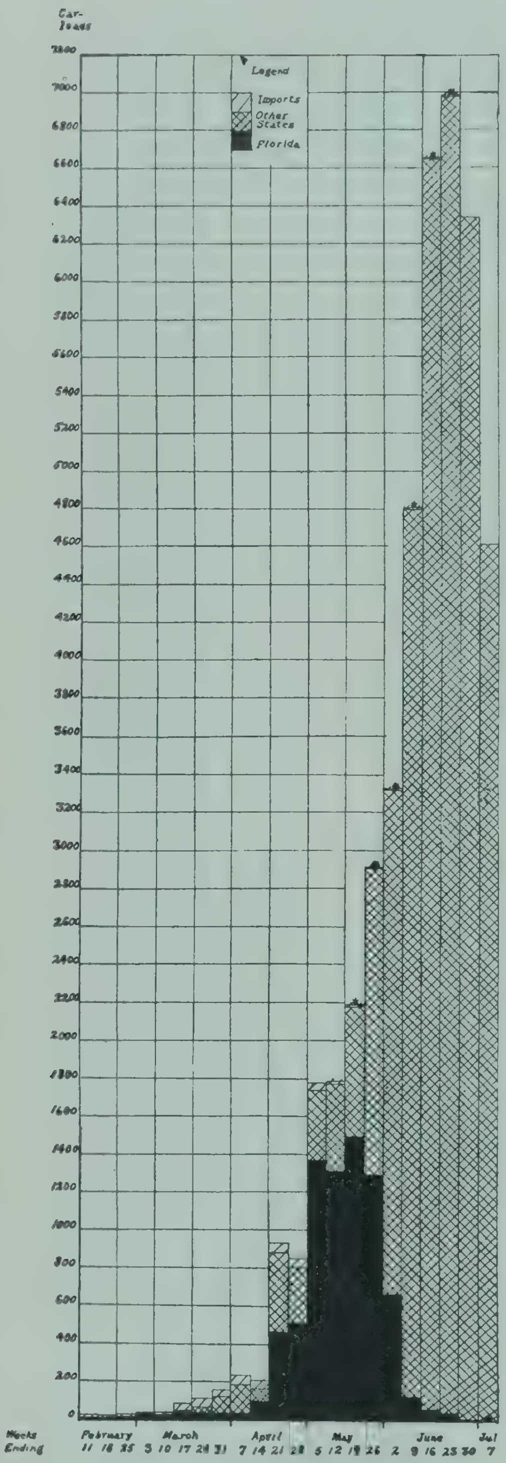

Chart 52.—Weekly car-lot shipments of white potatoes from Florida and total competition from other states and imports, 1928.

*Less than 5 carloads.

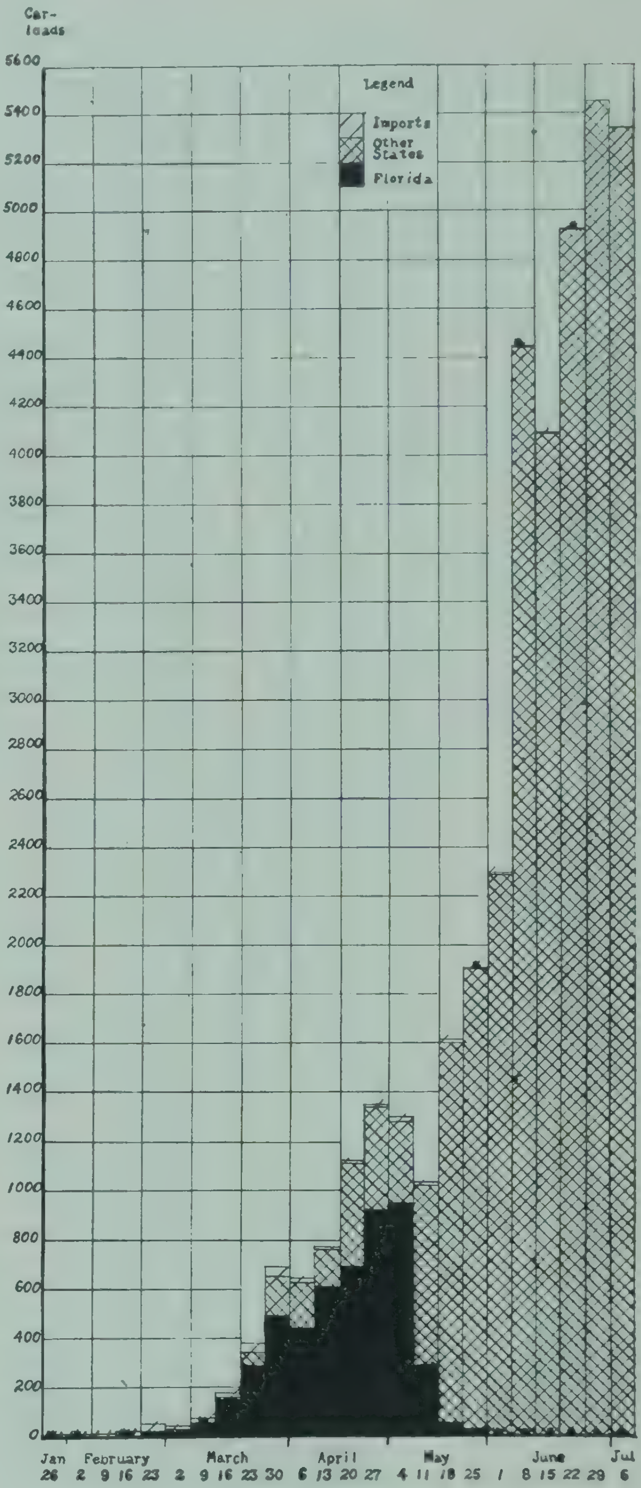

Chart 53.—Weekly car-lot shipments of white potatoes from Florida and total competition from other states and imports, 1929.

*Less than 5 carloads.

The heaviest competition that the Florida potato producers meet is with the northern or stored crop. These potatoes are harvested in the fall and large quantities go into storage for winter use. They may be stored on the farm or otherwise by the producers, or sold to dealers who may store a portion of the crop for speculative purposes. These potatoes are brought out of storage during the winter and placed on the market. As a general rule when the northern crop is heavy large quantities are stored and marketed late in the winter or in early spring. At such times there is not much chance of the price advancing to very attractive levels for the early potato producers. When the northern crop is light the market is likely to be cleared for the early southern product. As a matter of fact, however, the location of the northern crop is also of great importance. A crop of more than 400,000,000 bushels is a much more serious menace to the Florida producer if it was produced mostly in such surplus states as Maine and New York than if it had been produced in states farther removed from Florida's principal markets.

There were 81,602 carloads of stored potatoes from the late 1928 crop shipped while Florida was marketing her early potato crop in 1929. The movement from storage was very heavy that year, averaging about 5,000 carloads a week until the end of March. About that time, however, the storage movement was cut almost in half, thus leaving an opening for the early potato crop which had to be shipped greater distances. More than 20 states shipped stored potatoes while the early crop was being moved from Florida that year. There were 1,296 carloads of stored potatoes imported from Canada during that period. The Florida crop therefore had to meet heavy supplies of old potatoes in most all markets. It is well known that storage potatoes exert an appreciable effect upon the price of new potatoes, so it is important for Florida producers to take stock of the quantity of late northern potatoes being stored in planning their production of early potatoes. Stored potatoes, as a rule, are less desirable than new potatoes, but they are also cheaper. The consumption of new potatoes is therefore greatly reduced in years of heavy storage movements. If the supply of stored potatoes is small so that there is not much difference between the price of stored potatoes and new potatoes, then there will be a heavier demand for new potatoes (charts 54 to 58 and Appendix Tables XLVII to LI, inclusive).

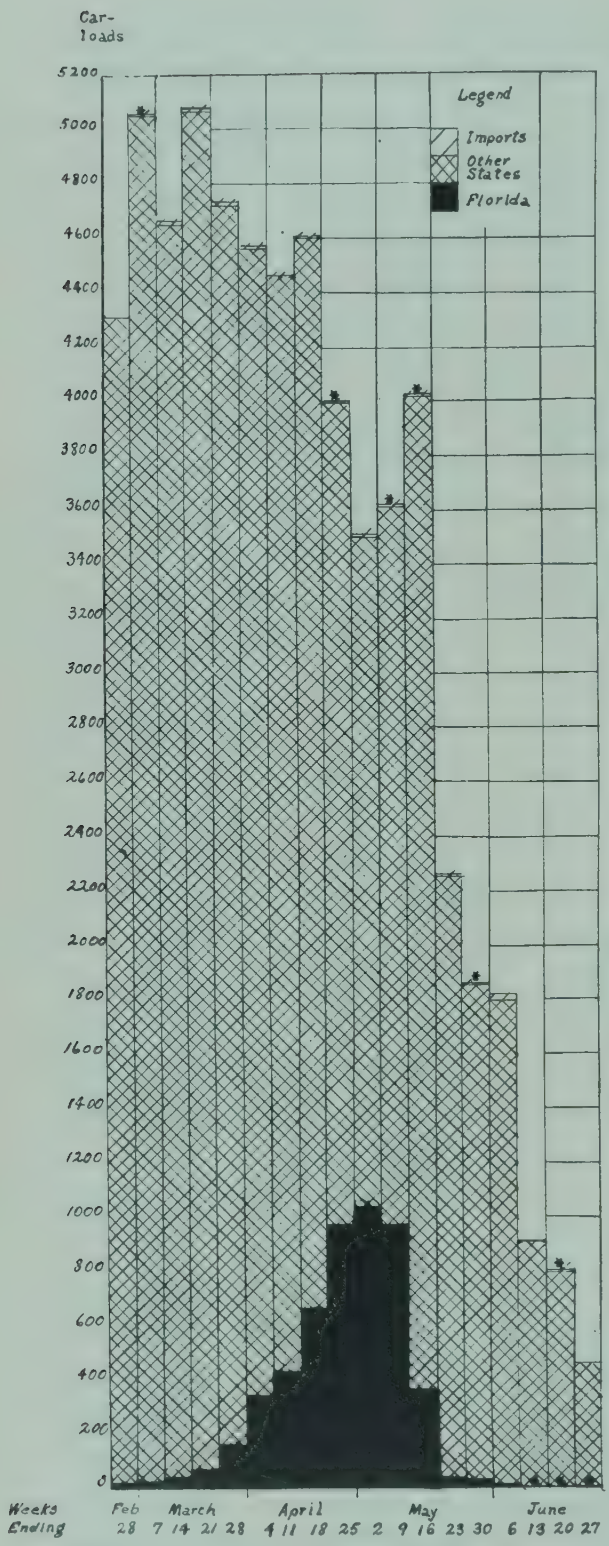

Chart 54.—Weekly car-lot shipments of white potatoes from Florida with total stored white potato competition from other states and imports, 1925.

*Less than 5 carloads.

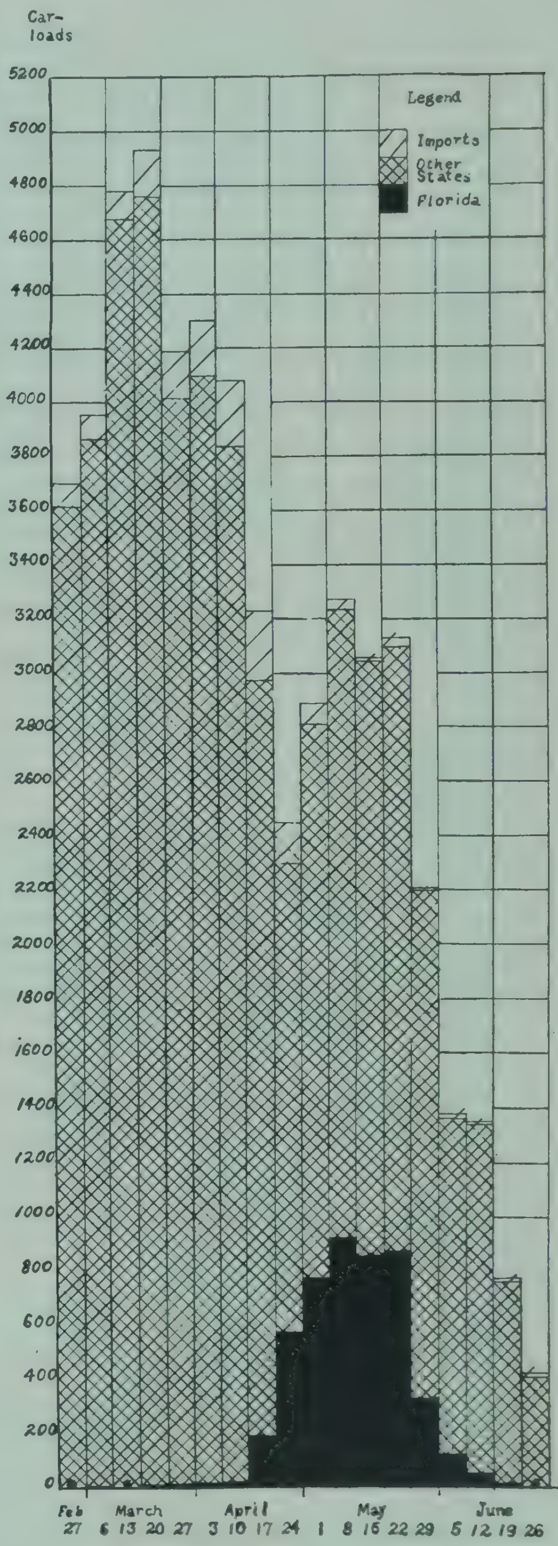

Chart 55.—Weekly car-lot shipments of white potatoes from Florida with total stored white potato competition from other states and imports, 1926.

*Less than 5 carloads.

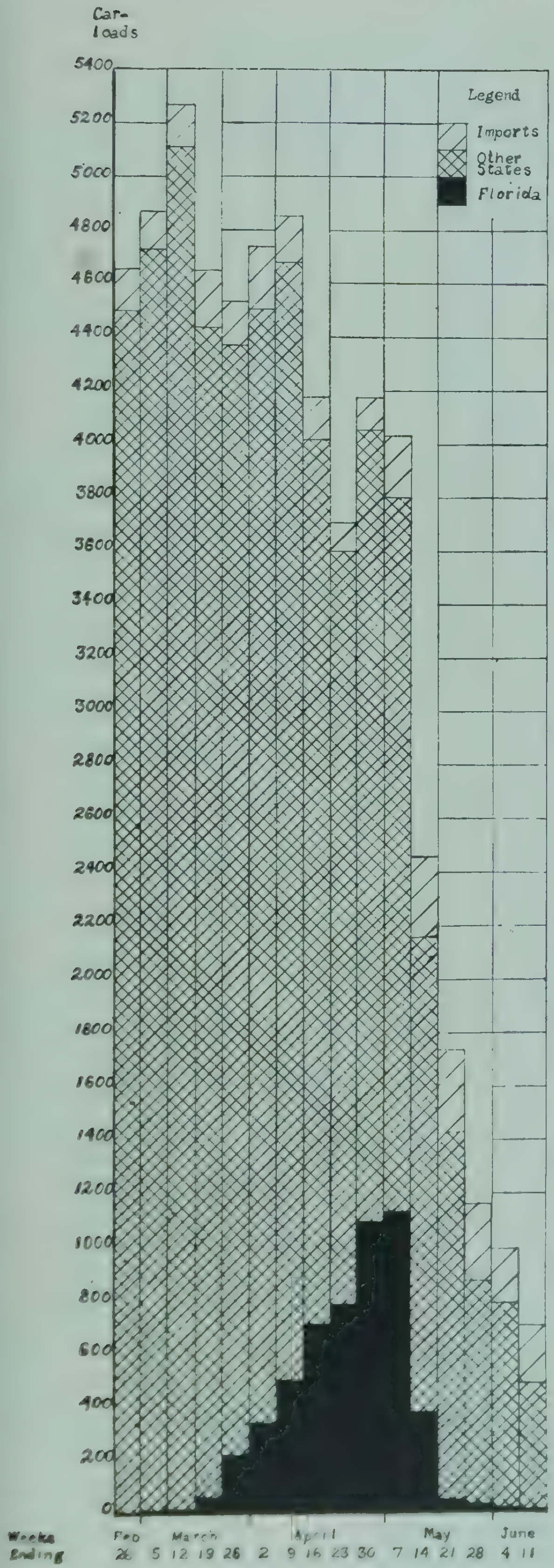

Chart 56.—Weekly car-lot shipments of white potatoes from Florida with total stored white potato competition from other states and imports, 1927.

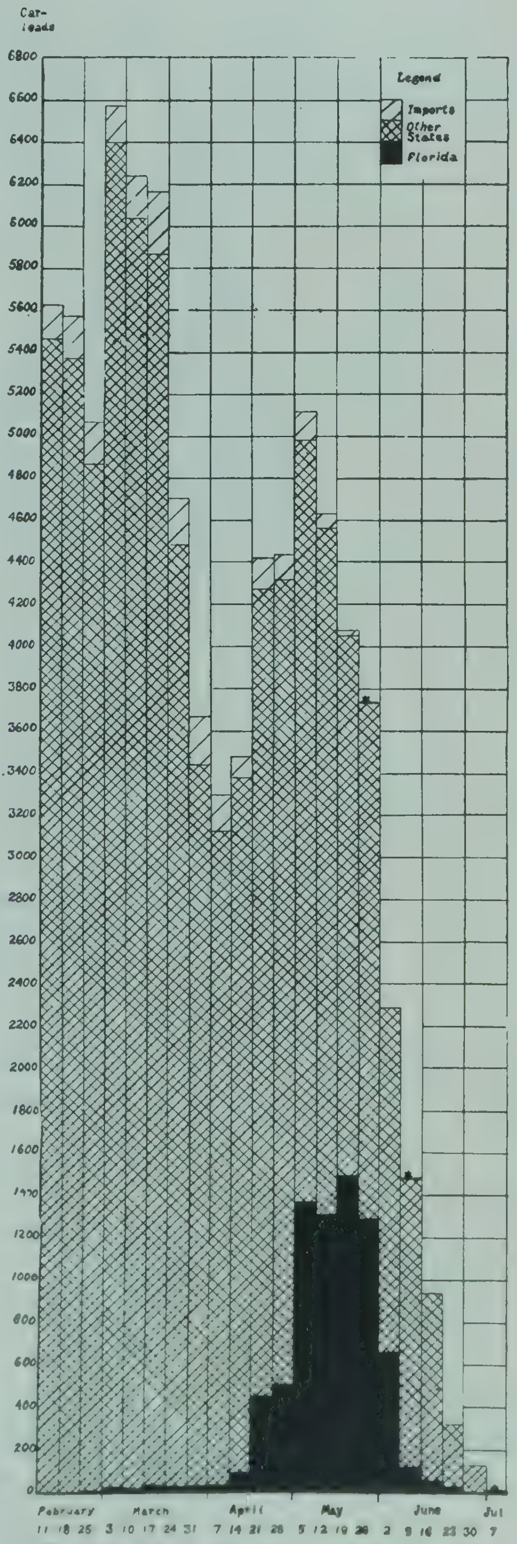

Chart 57.—Weekly car-lot shipments of white potatoes from Florida with total stored white potato competition from other states and imports, 1928.

*Less than 5 carloads.

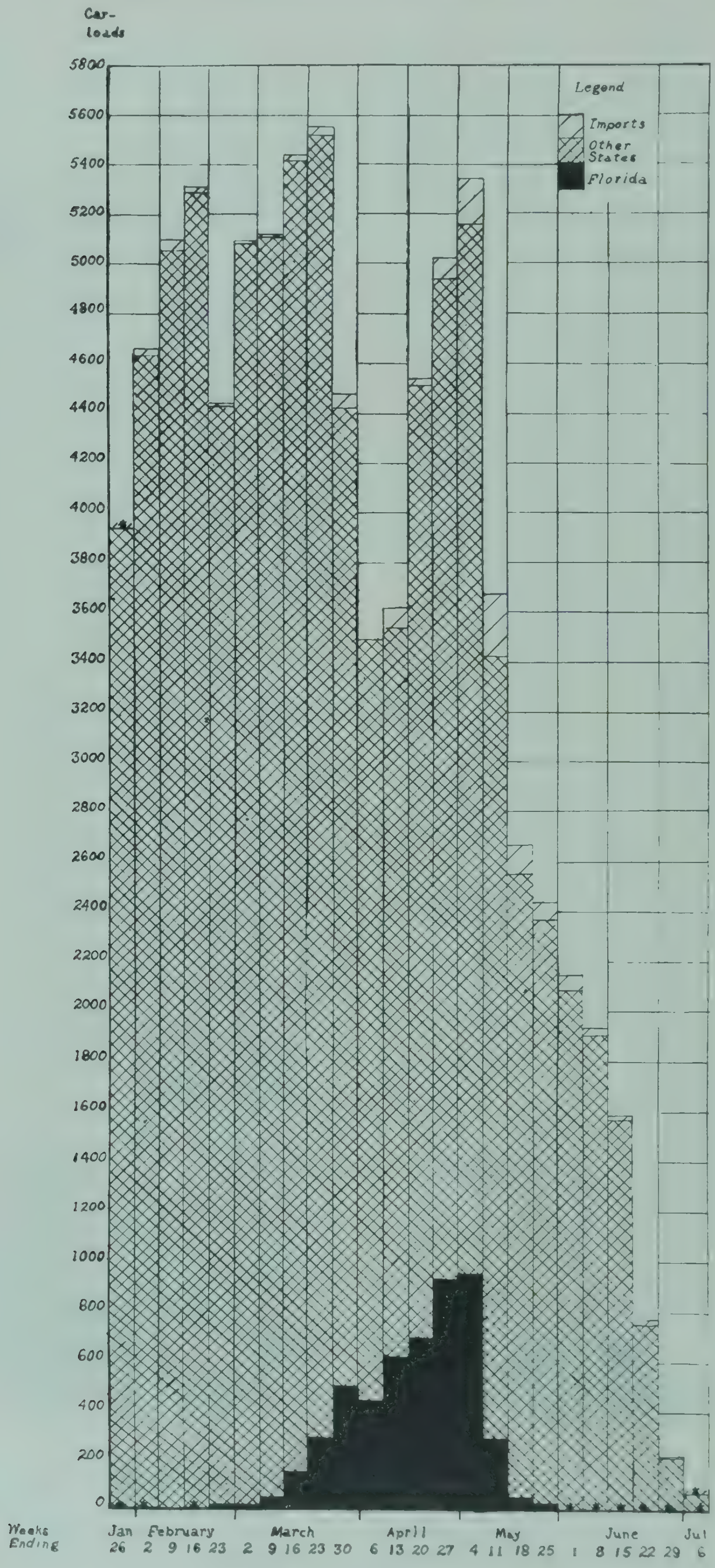

Chart 58.—Weekly car-lot shipments of white potatoes from Florida with total stored white potato competition from other states and imports, 1929.
*Less than 5 carloads.

STRAWBERRIES

Shipments of strawberries from Florida have been on the increase during recent years. Unlike the northern crop which remains in fruitage for only a few weeks, strawberries are picked from the Florida plants in late November and shipments reach appreciable volume in January with picking from the same plants continuing until rendered unprofitable by the competition from Louisiana and other states.

In 1929 Florida began shipping strawberries in carload lots the first week of January and it was not until the week ending March 23 that two carloads were shipped from Louisiana in competition with Florida. The next week, which ended March 30, Texas began with five carloads. Alabama began shipping during the week which ended on April 6, while Mississippi, North Carolina, and South Carolina began the following week. Arkansas, California, Georgia, Tennessee, and Virginia began shipping during the week which ended April 27 and Oklahoma began during the week which ended May 4. By this time the movement from Florida had decreased from 203 carloads shipped during the week before competition from other states began, to 3 carloads. In 1928 the situation was similar as to the dates of competition, but the volume shipped from Florida was much smaller. In 1927, however, Florida met competition from Louisiana at a much earlier date, that state having shipped 14 carloads during the week which ended February 26, while Florida was shipping 108 carloads. Shipments from Florida reached their peak two weeks later and were then forced to decline in the face of competition from Louisiana, Texas, and Alabama.

Shipments from Florida are in considerably greater volume than the car-lot movement data would indicate, since large quantities are shipped by express in pony refrigerators. This is especially true of berries picked in late November and December before there is sufficient volume for car-lot shipments by freight and the price is high enough to justify shipments by express. Shipments by this method are quite popular throughout most of the shipping season.

There is no competition from imports (charts 59 to 63 and Appendix Tables LIII to LVII, inclusive).

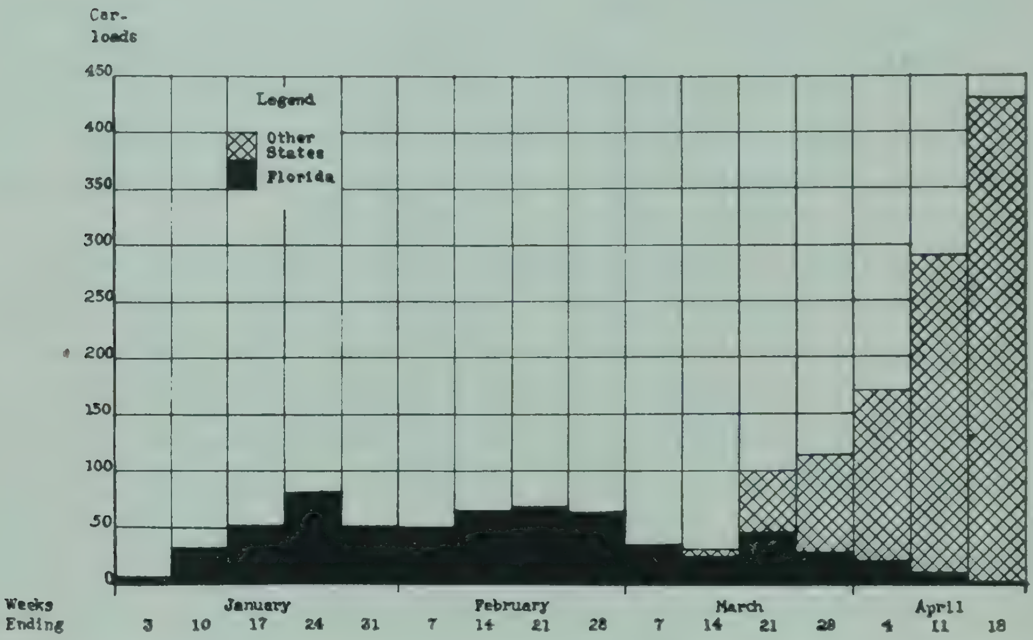

Chart 59.—Weekly car-lot shipments of strawberries from Florida and total competition from other states, 1925.

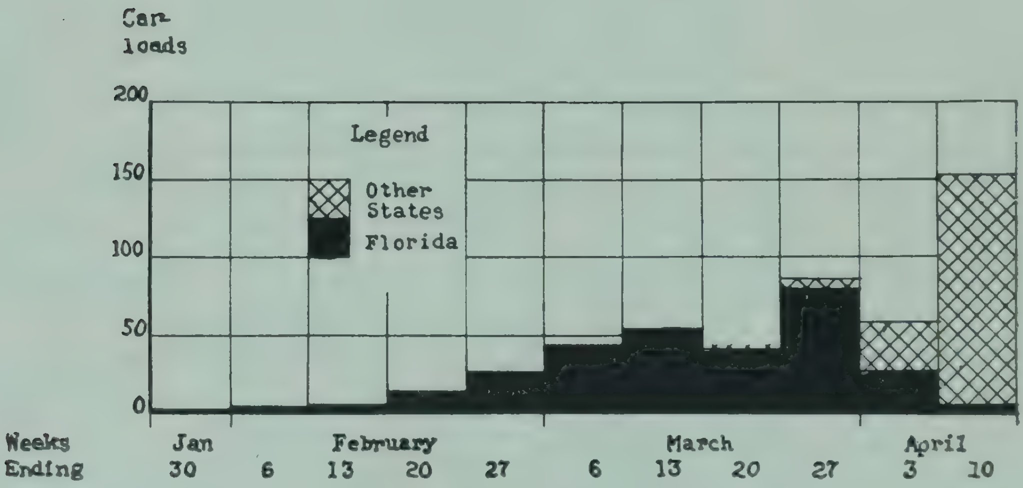

Chart 60.—Weekly car-lot shipments of strawberries from Florida and total competition from other states, 1926.

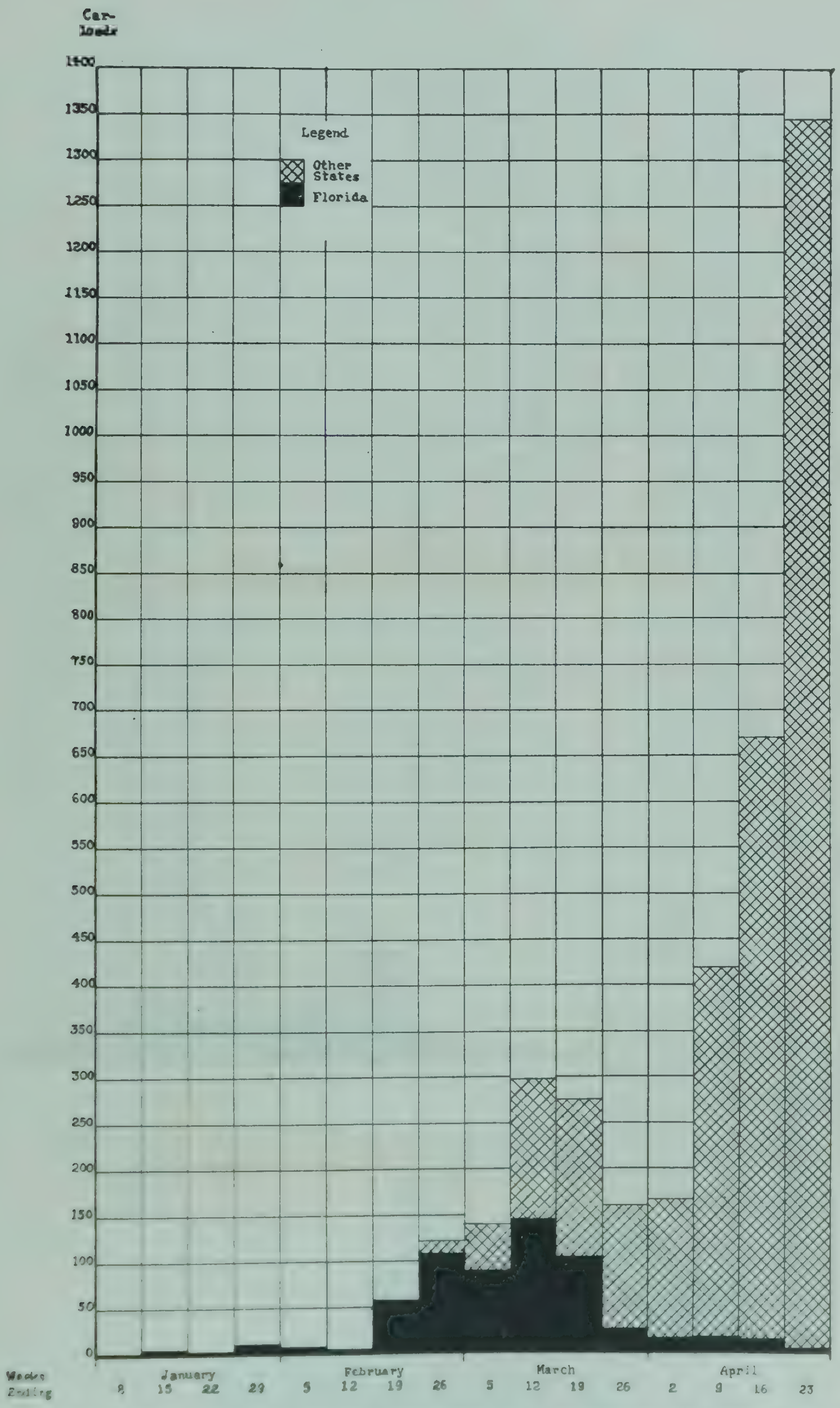

Chart 61.—Weekly car-lot shipments of strawberries from Florida and total competition from other states, 1927.

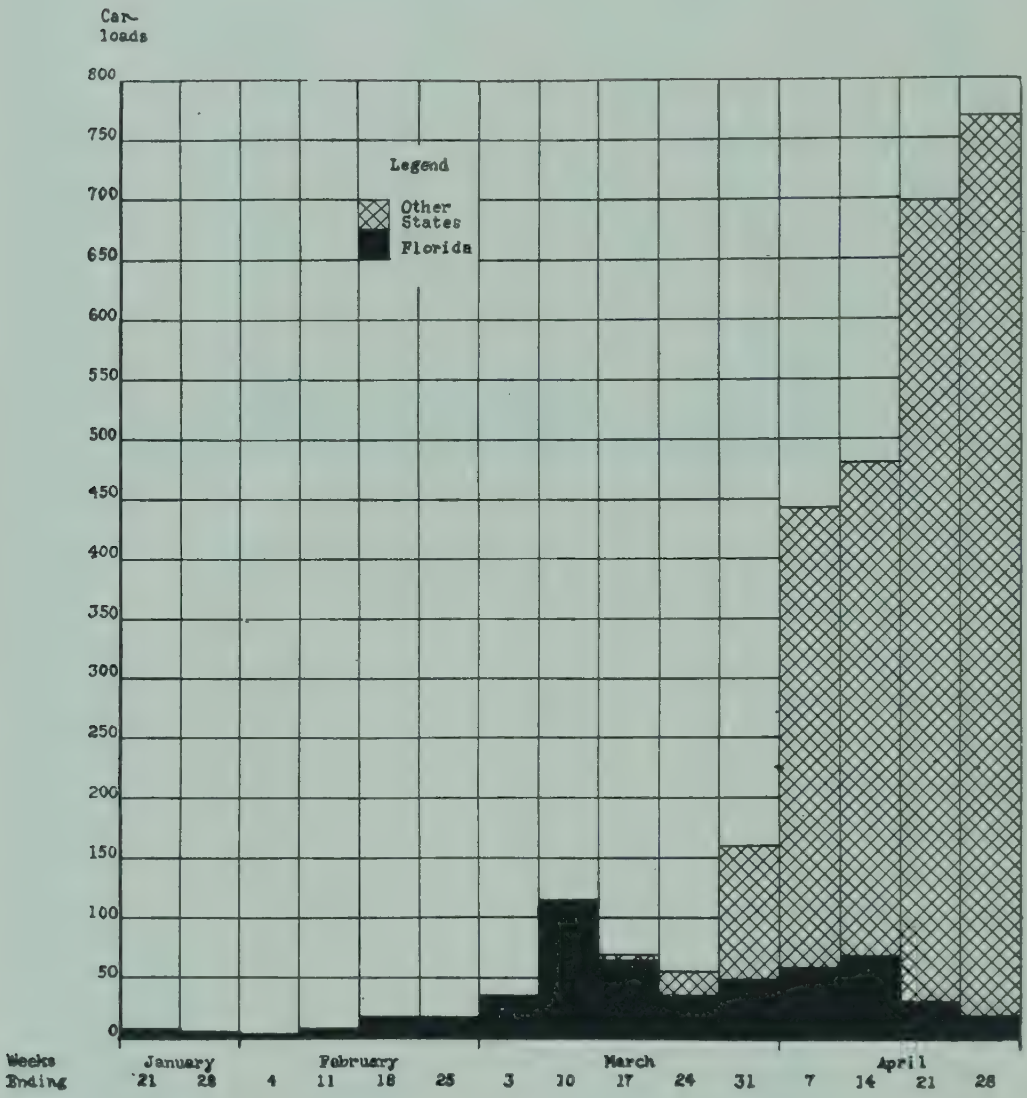

Chart 62.—Weekly car-lot shipments of strawberries from Florida and total competition from other states, 1928.

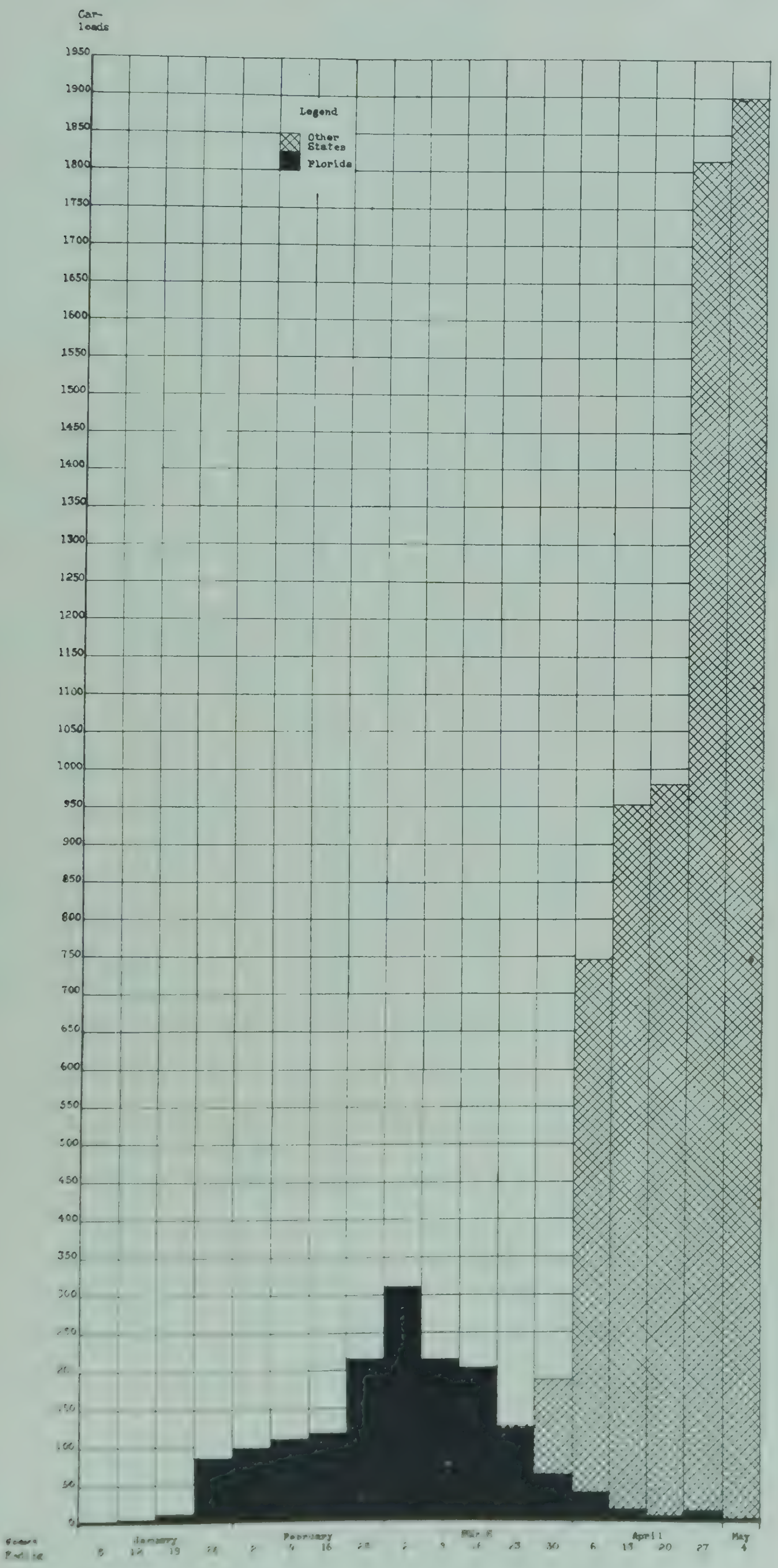

Chart 63.—Weekly car-lot shipments of strawberries from Florida and total competition from other states, 1929.

TOMATOES

Tomatoes are the most important truck crop produced in Florida in point of acreage, value and car-lot shipments. Florida normally begins shipping in November or early December from early plantings but the main crop in Dade County starts in January and shipments from this section are usually heavy in February, March, and the first half of April, reaching a peak some time in March. Manatee County and the Everglades section follow and the season finally ends with shipments from Marion and Sumter counties usually in early July.

Florida tomato producers experience little competition from other states during the winter months, but imports of tomatoes during this period have been increasingly important during the past few years. Florida opened the 1928-29 season with 13 carloads shipped during the week which ended November 10, 1928. These tomatoes were sold in competition with 327 carloads of fall tomatoes from California and a few carloads from Texas, Ohio, and other states. This fall competition ended with 4 carloads from Texas during the week which ended December 29, 1928. Competition with early tomatoes began with 1 carload imported from Cuba during the week which ended November 17, 1928. The following week there were imports from Cuba, Mexico, and the Bahamas. Imports from these three sources combined exceeded the shipments from Florida each week from the week ending December 1 to February 16, inclusive, and in total carloads for this period were almost double the Florida shipments. Again, during the two-week period March 22 to April 6, imports exceeded Florida shipments. Imports from the Bahamas closed with the week which ended March 2, 1929, from Cuba with the week ending April 27; while imports from Mexico extended through the week which ended June 1. Spring competition from other states began with light shipments from California and Texas during the week which ended on April 27, while shipments from Ohio, Georgia, Mississippi, South Carolina, Arkansas, and Washington began during the latter part of May and early June, just before the end of the Florida season.

The west coast of Mexico is the most important source of imports of tomatoes. Cuba and the Bahamas are also of considerable importance. The movement from the Mexican west coast runs from November through to June with the peak movement during the four months January to the end of April. Shipments from Cuba come in from November to April but mostly during the four months December to the end of March. The Bahama crop comes in from November to March and is at its peak during December and January. The competition of tomatoes from Cuba and the Bahamas is particularly keen in the large eastern markets. Mexican tomatoes compete mainly in the central and western markets but considerable quantities are shipped to the eastern markets also (charts 64 to 68 and Appendix Tables LIX to LXIII, inclusive).

Imports of tomatoes during the Florida shipping season increased greatly during the six-season period, 1923-24 to 1928-29. This increase is indicated in Table VI.

TABLE VI.—IMPORTS OF TOMATOES INTO THE UNITED STATES, 1923-24 TO 1928-29

Season	Mexico	Cuba	Bahamas	Other	Total
1923-24	375	....	....	--	375
1924-25	2,630	84	79	--	2,793
1925-26	2,979	538	270	--	3,787
1926-27	4,521	619	294	9	5,443
1927-28	4,061	802	366	--	5,229
1928-29	4,604	1,284	402	1	6,291

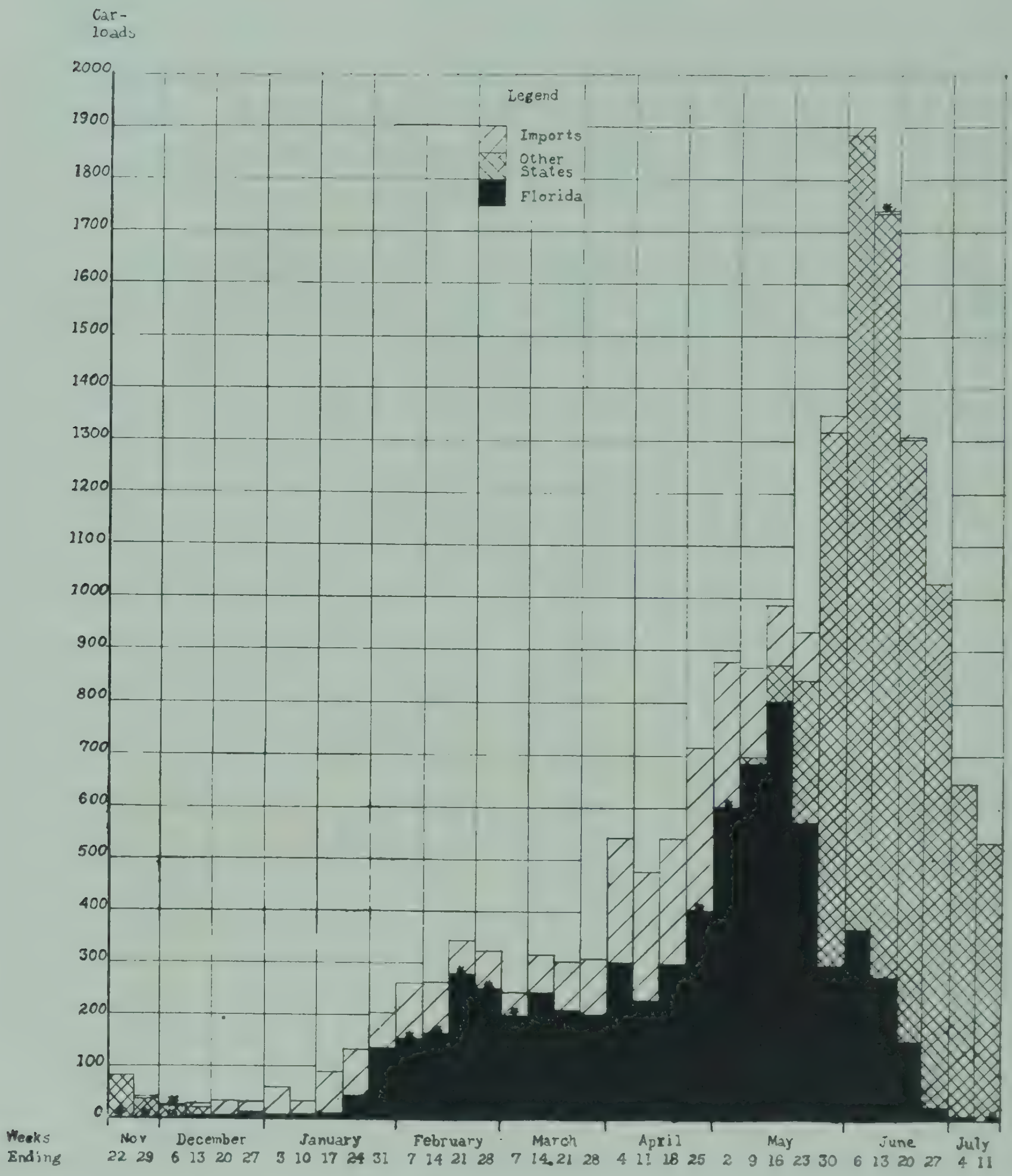

Chart 64.—Weekly car-lot shipments of tomatoes from Florida and total competition from other states and imports, 1924-1925 season.
*Less than 5 carloads.

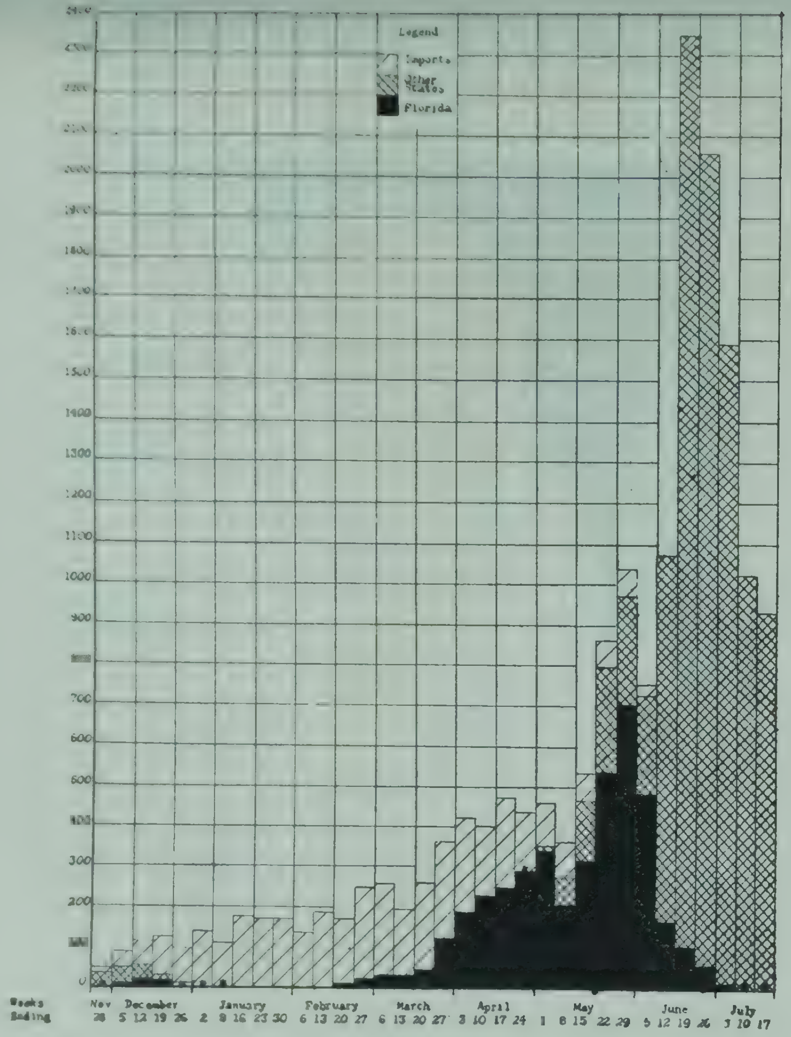

Chart 65.—Weekly car-lot shipments of tomatoes from Florida and total competition from other states and imports, 1925-1926 season.
*Less than 5 carloads.

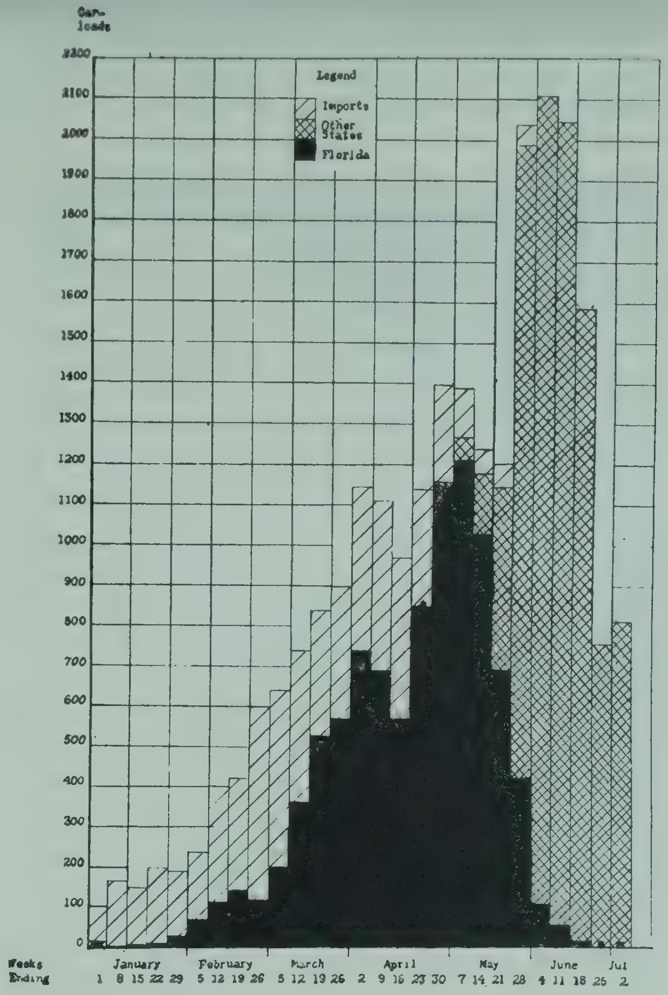

Chart 66.—Weekly car-lot shipments of tomatoes from Florida, and total competition from other states and imports, 1927.
*Less than 5 carloads.

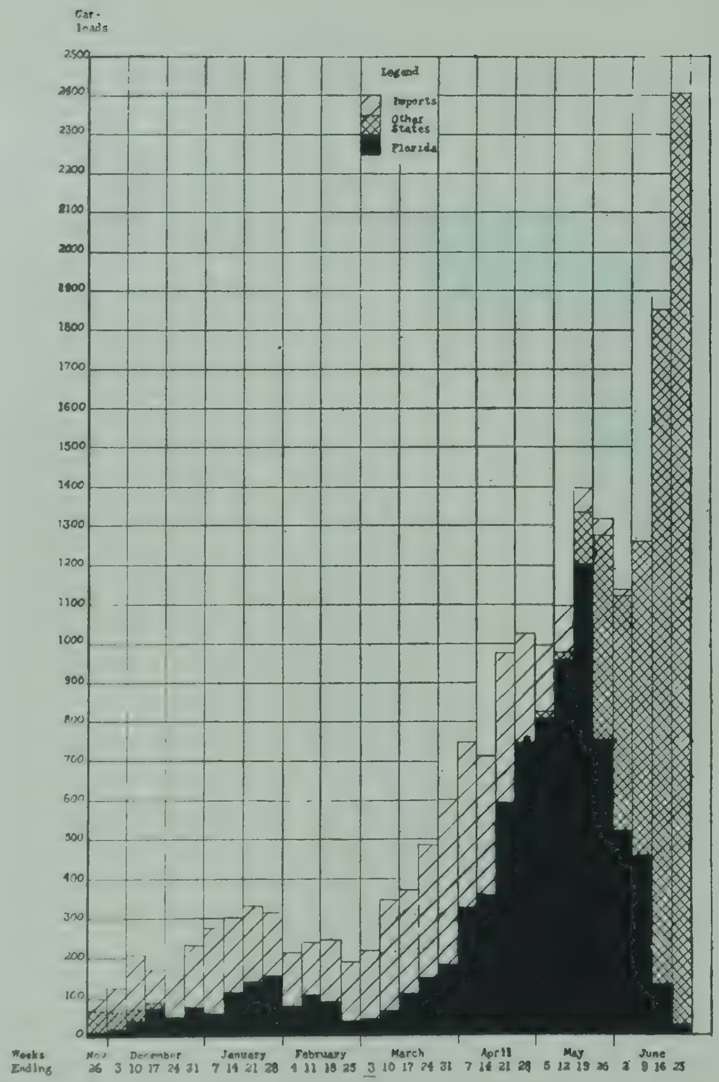

Chart 67.—Weekly car-lot shipments of tomatoes from Florida and total competition from other states and imports, 1927-1928 season.

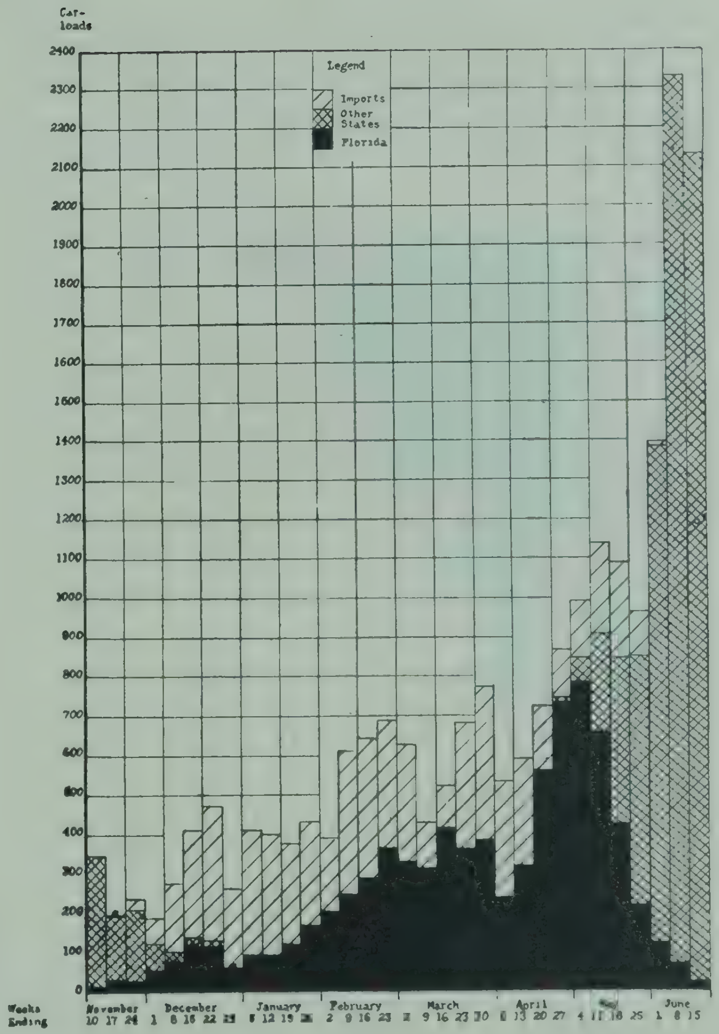

Chart 68.—Weekly car-lot shipments of tomatoes from Florida and total competition from other states and imports, 1928-1929 season.
*Less than 5 carloads.

WATERMELONS

During the eight-year period from 1922 to 1929, inclusive, Florida shipped an annual average of 7,794 carloads of watermelons as against an average of 8,055 carloads of tomatoes shipped each year during this period. Tomatoes were the only truck crop to exceed watermelons in volume of movement. The car-lot value is less than for most truck crops, however, so that in point of value watermelons occupy about fifth place among the truck crops of the state.

Movement of watermelons from Florida usually begins with a few cars about May 1 and extends through July, with the peak of the movement about the middle of June. Georgia, the strongest competing state, usually begins shipping in June and furnishes competition for the rest of the season but misses the high market for the early shipments. In 1929 the Florida season opened with five carloads during the week which ended April 20, and increased rapidly to 566 carloads during the week which ended May 18, when the first competition was encountered to the extent of three carloads from Texas. California began shipping the following week. Arizona, Georgia, Alabama, Mississippi, and South Carolina followed in rapid succession. Competition from Georgia was more important than from all other sources combined. Florida, however, was more than half through her shipping season when Georgia began, the latter state shipping 7 carloads as against 2,609 carloads from Florida during the week which ended June 8. From that time, however, Georgia increased her shipments rapidly, reaching a peak of 5,222 carloads during the week of June 21 to 29, while shipments from Florida rapidly decreased. Shipments from Florida during the last two weeks of the season were from the extreme northern part of the state (charts 69 to 73 and Appendix Tables LXV to LXIX, inclusive).

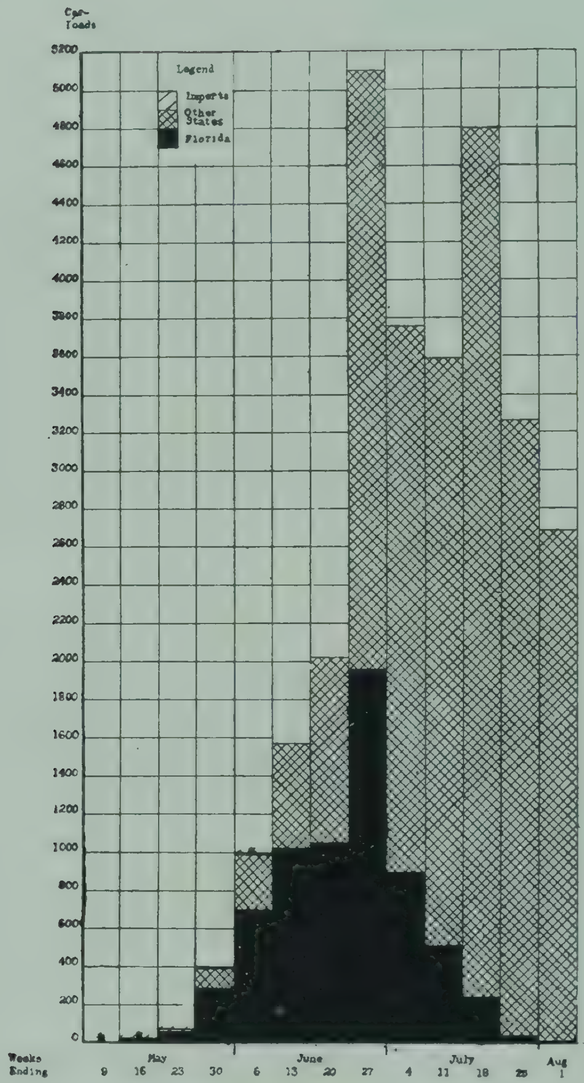

Chart 69. — Weekly car-lot shipments of watermelons from Florida and total competition from other states and imports, 1925.
*Less than 5 carloads.

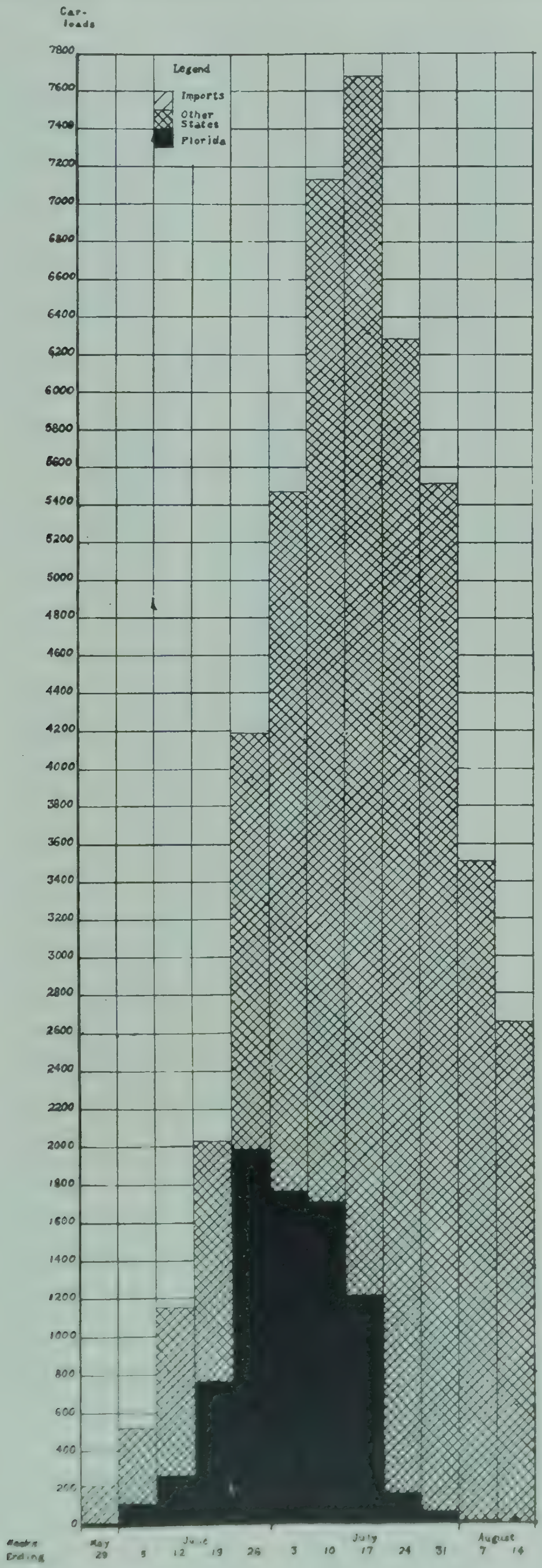

Chart 70.—Weekly car-lot shipments of watermelons from Florida and total competition from other states, 1926.

[1]Less than 5 carloads.

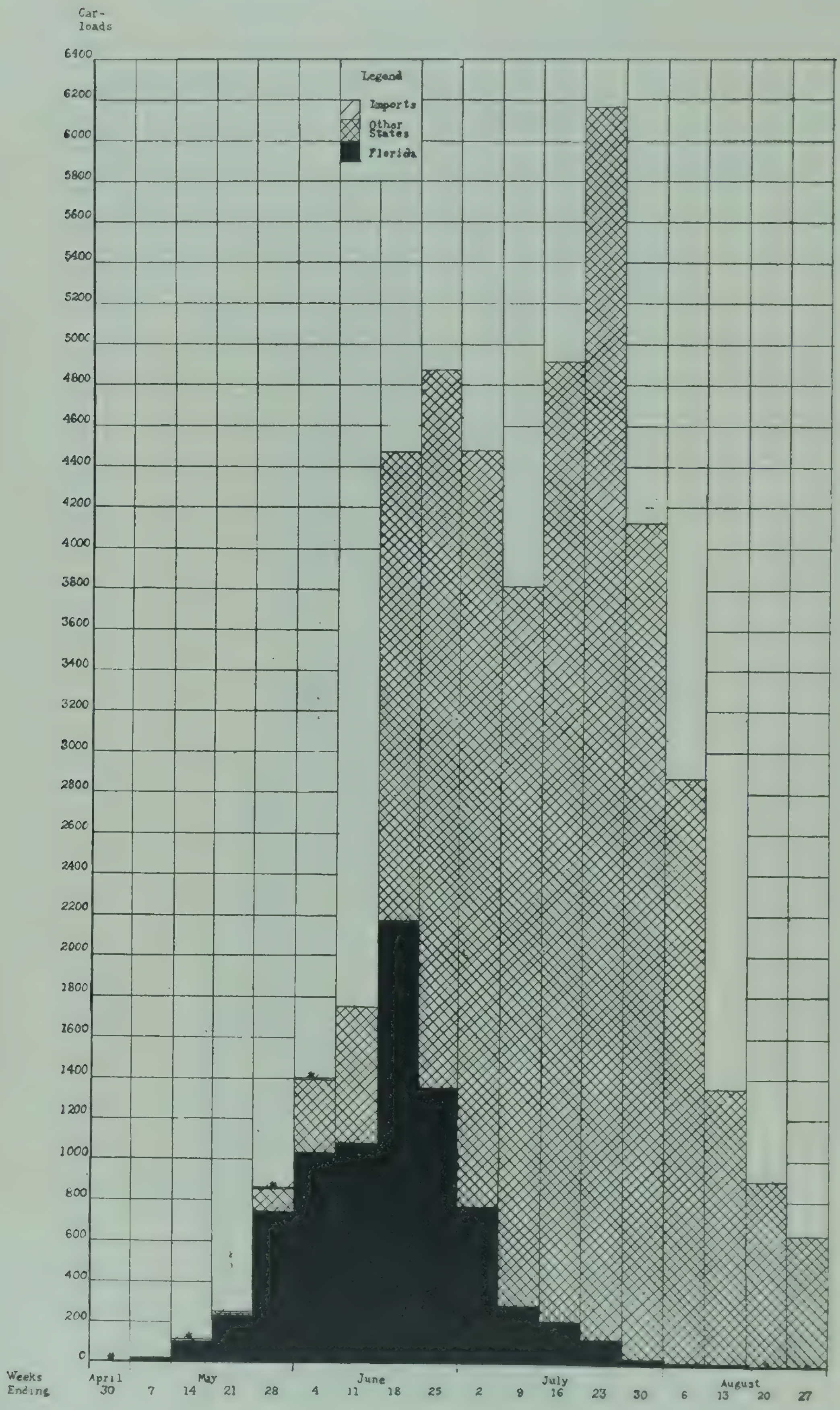

Chart 71.—Weekly car-lot shipments of watermelons from Florida and total competition from other states and imports, 1927.
*Less than 5 carloads.

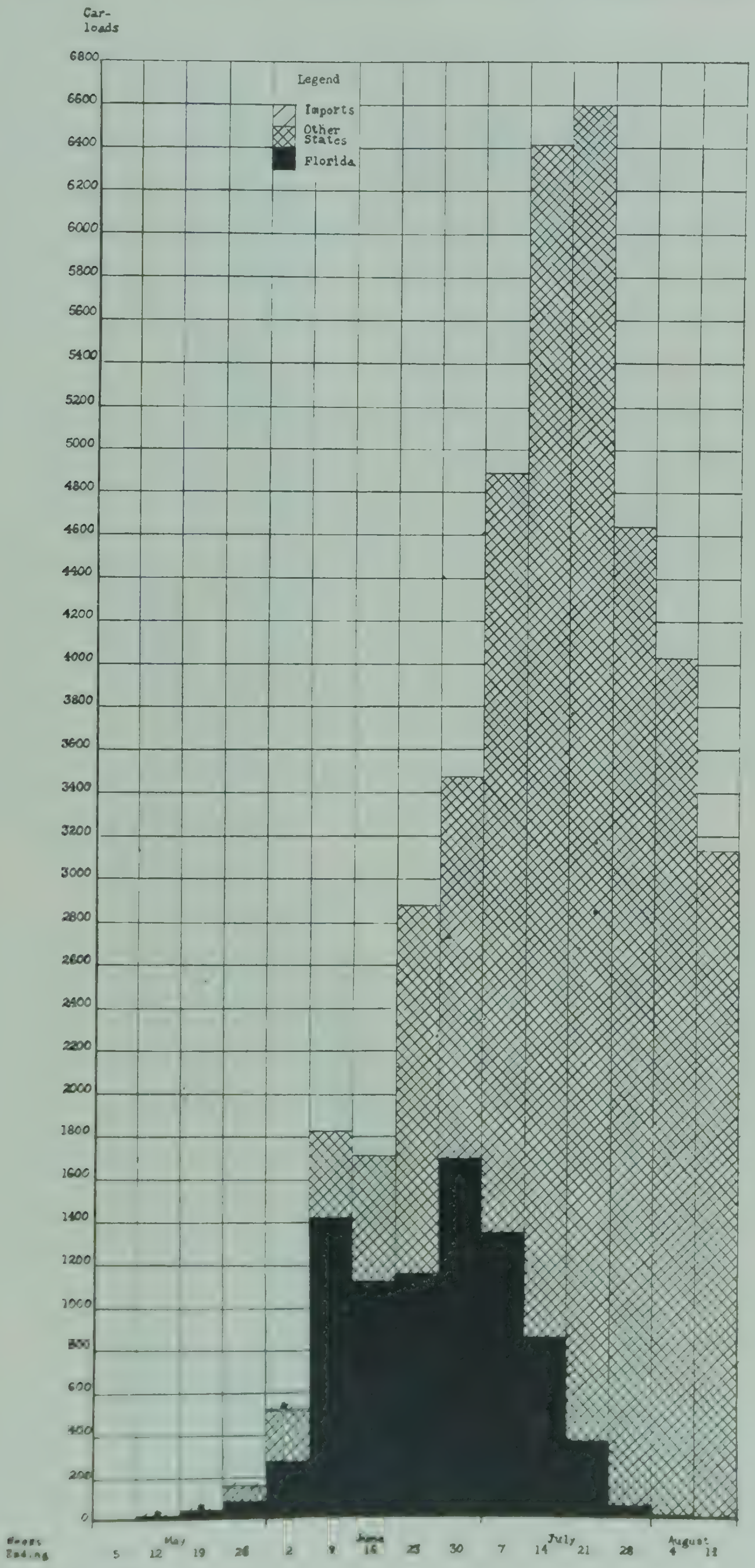

Chart 72.—Weekly car-lot shipments of watermelons from Florida and total competition from other states and imports, 1928.

*Less than 5 carloads.

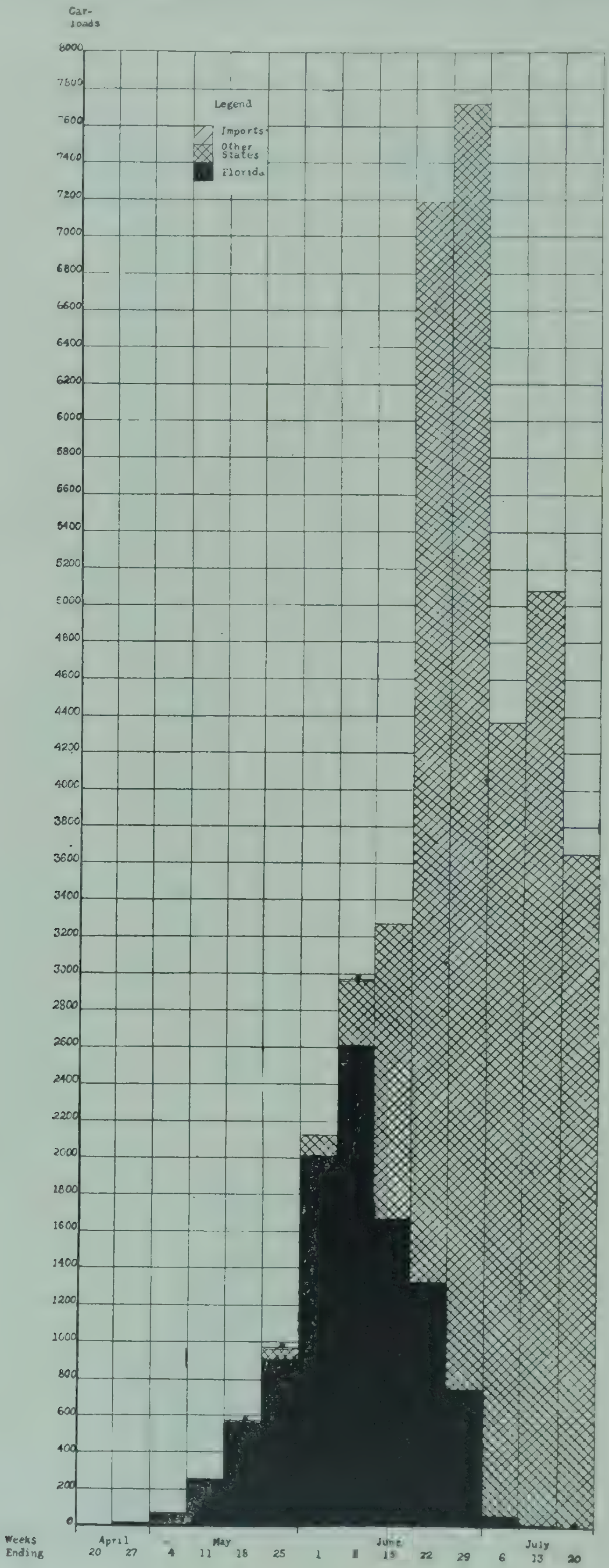

Chart 73.—Weekly car-lot shipments of watermelons from Florida and total competition from other states and imports, 1929.
*Less than 5 carloads.

MISCELLANEOUS CROPS

The other recorded truck crops that moved in car-lots at any time during the five-season period 1924-1925 to 1928-1929 are briefly mentioned. None of these crops is of general economic importance in Florida, though each one has a definite place on a limited number of Florida farms.

CANTALOUPES

Cantaloupes are of minor importance in Florida and shipments have trended downward during the past 10 years. This is due both to tremendous competition from other states and to difficulties of production because of insect pests and plant diseases. Although competition is very keen from California and Arizona after the middle of May, prior to that time there is a minimum of competition and probably an opening for shipments from Florida if cantaloupes could be produced economically in this state at that season. Mexico ships a few carloads of cantaloupes into the United States during April and May, but competition from that source is not serious (Appendix Tables LXXI to LXXV, inclusive).

CAULIFLOWER

Shipments of cauliflower from Florida are light but have been increasing in importance during the past few years, having increased from 2 carloads in 1925 to 25 carloads in 1929. Any material gain in shipments of this crop, however, must be in the face of severe competition from California, Arizona, and Texas, during the entire Florida shipping season. California leads in the production of cauliflower and shipments from that source are well established in the markets of this country. The normal Florida season is January to March.

ONIONS

Onions move from Florida to a very limited extent in April, May and early June. In 1928 there were 19 carloads but in 1929 only 2 carloads moved from Florida. The competition from Texas and California is severe.

INTRA-STATE COMPETITION BEING STUDIED

Recognizing the fact that for a number of truck crops Florida's greatest competition is with herself, this study is being extended to bring out the competition between different sections of Florida. In making this further study, Government reports have proven inadequate. The cooperation of all transportation agencies serving the state has been obtained to the extent that they have made their files accessible from which the weekly movement of each truck crop from every shipping point of importance in the state has been compiled for the 1928-1929 season. Not only the freight car-lot movement, but the express and boat movement as well have been obtained. The results of this study will appear in a later publication.

APPENDIX

TABLE I.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF STRING BEANS BY STATES AND IMPORTS FOR SEASON 1924-1925.

Week Ending	DOMESTIC																		IMPORTS			
	Fla.	Cal.	Tex.	La.	Ala.	Miss.	Ga.	N. C.	S. C.	Va.	Tenn.	Ark.	Del.	Md.	Okla.	N. J.	Other States	Total Domestic	Cuba	Can-ada	Total Imports	Total All Sources
Dec. 6	8																	8				8
Dec. 13	9																	9				9
Dec. 20	13																	13				13
Dec. 27	51																	51				51
Jan. 3	98	2																100				100
Jan. 10	134																	134				134
Jan. 17	104																	104				104
Jan. 24	75																	75				75
Jan. 31	63	4																67				67
Feb. 7	25	1																26				26
Feb. 14	24	12																36				36
Feb. 21	34																	34	2		2	36
Feb. 28	13																	13				13
Mar. 7	10																	10				10
Mar. 14	25																	25				25
Mar. 21	33																	33				33
Mar. 28	25		1															26		2	2	28
Apr. 4	58	1	33															92				92
Apr. 11	129		60															189				189
Apr. 18	247	3	135															385				385
Apr. 25	297	2	114	44														457				457
May 2	276	1	12	143	2	18												452				452
May 9	159	7	3	107	5	23	2	4	43									353				353
May 16	20	9		89	5	11	5	14	91									244				244
May 23	7	3	1	46	7	4	3	3	72	2								148				148
May 30	8	5	1	21	9	5	1	31	43		5						1	130				130
June 6	4	5		46	12	8	4	189	34	58	36	3	1				1	401				401
June 13	2			5			1	167	2	141	26	1		6	4			355				355
June 20	1							21	3	83				5		2	15	130				130
Total	1952	55	360	501	40	69	16	429	288	284	67	4	1	11	4	2	17	4100	2	2	4	4104

TABLE II.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF STRING BEANS BY STATES AND IMPORTS FOR SEASON 1925-1926.

	DOMESTIC															Imports		
Week Ending	Fla.	Texas	La.	S. C.	Va.	Cal.	Ala.	Ga.	Miss.	N. C.	Ky.	Ark.	Tenn.	Other States	Total Domestic	Cuba	Total Imports	Total All Sources
Nov. 7	1	4	38	7	4									3	57			57
Nov. 14	6	19	34	3											62			62
Nov. 21	27	23	17	5										2	74			74
Nov. 28	23	21												1	45			45
Dec. 5	26	4													30			30
Dec. 12	45														45			45
Dec. 19	33														33			33
Dec. 26	13														13			13
Jan. 2	16														16			16
Jan. 9	15														15			15
Jan. 16	21														21			21
Jan. 23	8														8			8
Jan. 30	6														6			6
Feb. 6	5														5			5
Feb. 13	2														2			2
Feb. 20	3														3			3
Feb. 27	2														2			2
Mar. 6																		
Mar. 13	1														1			1
Mar. 20	1	4													5			5
Mar. 27	22														22	3	3	25
Apr. 3	36	33													69	2	2	71
Apr. 10	44	117													161	2	2	163
Apr. 17	74	91													165			165
Apr. 24	91	64				4									159			159
May 1	56	9				30									95			95
May 8	87	2				17									106			106
May 15	124	7	17			19									167			167
May 22	47	1	32	43		8	6	5	19						161			161
May 29	11	1	72	195		1	13	15	37	21					366			366
June 5	8	3	83	83	7		12	15	40	103	3				357			357
June 12	1		51	20	56		4	5	15	151		1	29		333			333
Total	855	403	344	356	67	79	35	40	111	275	3	1	29	6	2604	7	7	2611

TABLE III.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF STRING BEANS BY STATES AND IMPORTS FOR SEASON 1926-1927.

	DOMESTIC															IMPORTS			
Week Ending	Fla.	La.	S. C.	Miss.	N. C.	Va.	Texas	Cal.	Ala.	Ga.	Tenn.	Ill.	Md.	Other States	Total Domestic	Mexico	Bermuda	Total Imports	Total All Sources
Oct. 23	4	65	17	3	40	143								3	275				275
Oct. 30	6	53	34	3	14	44								1	155				155
Nov. 6	18	59	7	1	1	33									119				119
Nov. 13	19	34				10	2								65				65
Nov. 20	41	1					13								55				55
Nov. 27	35						10								45				45
Dec. 4	68						9								77				77
Dec. 11	53														53				53
Dec. 18	62														62				62
Dec. 25	58														58				58
Jan. 1	71														71				71
Jan. 8	23														23				23
Jan. 15	8														8				8
Jan. 22	4														4				4
Jan. 29	2														2				2
Feb. 5	6														6				6
Feb. 12	8						1								9				9
Feb. 19	13														13				13
Feb. 26	23														23	1		1	24
Mar. 5	63														63	1	1	2	65
Mar. 12	77														77				77
Mar. 19	149						10								159				159
Mar. 26	136						29								165				165
Apr. 2	129						80								209				209
Apr. 9	149		2				128	1							280				280
Apr. 16	126		1				62								189				189
Apr. 23	198	14		1			13								226				226
Apr. 30	355	46		1			2		1	1					406				406
May 7	354	123	29	10			1	3	16	13					549				549
May 14	128	121	136	41			4	21	17	33					501				501
May 21	27	63	108	38	2		3	12	13	19					285				285
May 28	16	41	63	18	35	2		10	9	24	2				220				220
June 4	9	2	19	5	89	6		1	3		1			1	136				136
June 11	6	1	6	1	127	47					3				191				191
June 18	3	2	8		149	196				1	18	1	3	2	383				383
Total	2447	625	430	122	457	481	367	48	59	91	24	1	3	7	5162	2	1	3	5165

TABLE IV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF STRING BEANS BY STATES AND IMPORTS FOR SEASON 1927-1928.

	DOMESTIC														IMPORTS			
Week Ending	Fla.	La.	S. C.	Va.	N. C.	Texas	Cal.	Ala.	Ga.	Miss.	Ark.	Tenn.	Other States	Total Domestic	Cuba	Mexico	Total Imports	Total All Sources
Oct. 22	3	36	15	64	6								2	126				126
Oct. 29	16	76	33	78	9								3	215				215
Nov. 5	73	58	23	83		4							8	249				249
Nov. 12	115	47		12		21							3	198				198
Nov. 19	271	25				32							1	329				329
Nov. 26	152													152				152
Dec. 3	198													198	2		2	200
Dec. 10	120													120				120
Dec. 17	160													160				160
Dec. 24	116													116				116
Dec. 31	35													35				35
Jan. 7	20													20				20
Jan. 14	14													14				14
Jan. 21	31													31				31
Jan. 28	24													24				24
Feb. 4	25													25				25
Feb. 11	23													23				23
Feb. 18	24													24		1	1	25
Feb. 25	29													29				29
Mar. 3	30													30		1	1	31
Mar. 10	32													32				32
Mar. 17	44					7								51				51
Mar. 24	39					11								50				50
Mar. 31	54					24	1							79				79
Apr. 7	52					37								89				89
Apr. 14	117					5	1							123				123
Apr. 21	137					25	5							167				167
Apr. 28	313					24	11							348				348
May 5	156	21				68	19							264				264
May 12	90	110	11	1		22	15	8	2	1				260				260
May 19	28	163	39			5	25	11	4	23				298				298
May 26	11	88	124		5	12	22	8	5	25				300				300
June 2	6	76	109	20	74	10	5	20	8	72			1	401				401
June 9	5	32	100	66	391		4	8	22	20	2	5		655				655
Total	2563	732	454	324	485	307	108	55	41	141	2	5	18	5235	2	2	4	5239

TABLE V.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF STRING BEANS BY STATES AND IMPORTS FOR SEASON 1928-1929.

	DOMESTIC														IMPORTS			
Week Ending	Fla.	La.	S. C.	Va.	Texas	Cal.	Ala.	Ga.	Miss.	N. C.	Ark.	Md.	Other States	Total Domestic	Cuba	Mexico	Total Imports	Total All Sources
Nov. 3	3	63	4	21									4	95				95
Nov. 10	7	36	4	21									2	70				70
Nov. 17	21	12	12	5	3								3	56	2		2	58
Nov. 24	87		9		13								6	115	1		1	116
Dec. 1	43		2		8								1	54		1	1	55
Dec. 8	74				11								6	91				91
Dec. 15	45				4									49				49
Dec. 22	34													34				34
Dec. 29	32													32		1	1	33
Jan. 5	15													15		5	5	20
Jan. 12	18													18		4	4	22
Jan. 19	19													19		10	10	29
Jan. 26	24													24		14	14	38
Feb. 2	47													47		14	14	61
Feb. 9	50													50		5	5	55
Feb. 16	70													70		4	4	74
Feb. 23	130													130				130
Mar. 2	180													180				180
Mar. 9	150				1									151				151
Mar. 16	179													179				179
Mar. 23	119				2									121				121
Mar. 30	173				34									207				207
Apr. 6	191				111	1								303				303
Apr. 13	326				52									378				378
Apr. 20	313	1	1		46									361				361
Apr. 27	350	29	1		31									411				411
May 4	256	128	21		21	4	5	15	16					466				466
May 11	148	253	161		7	14	17	43	52					695				695
May 18	34	142	216			22	27	37	56	22				556				556
May 25	7	39	83	30	1	11	14	22	32	151	1			391				391
June 1	9	40	29	80		5	5	6	22	304	6	2		508				508
Total	3154	743	543	157	345	57	68	123	178	477	7	2	22	5876	3	58	61	5937

TABLE VI.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF STRING BEANS BY STATES AND IMPORTS FOR SEASON 1929-1930.

Week Ending	DOMESTIC																			IMPORTS			
	Fla.	Ark.	La.	Miss.	N. C.	S. C.	Va.	Tex.	Ala.	Cal.	Ga.	Tenn.	Ill.	Md.	Okla.	N. J.	Del.	Other States	Total Domestic	Mexico	Cuba	Total Imports	Total All Sources
Oct. 26	1	8	67	7	8	61	67											1	220				220
Nov. 2	13		4		4	49	29											3	102				102
Nov. 9	31		20			32	38	3										2	126				126
Nov. 16	31					7	4	19											61				61
Nov. 23	60							4										1	65				65
Nov. 30	164							11											175				175
Dec. 7	144																		144				144
Dec. 14	356																		356				356
Dec. 21	301																		301	2		2	303
Dec. 28	139																		139	3		3	142
Jan. 4	138																		138				138
Jan. 11	146																		146				146
Jan. 18	133																		133	2		2	135
Jan. 25	140																		140	1		1	141
Feb. 1	115																		115	3		3	118
Feb. 8	95																		95				95
Feb. 15	98																		98				98
Feb. 22	117																		117				117
Mar. 1	142																		142				142
Mar. 8	130																		130				130
Mar. 15	86																		86				86
Mar. 22	70							5											75		2	2	77
Mar. 29	61							26											87		2	2	89
Apr. 5	59							89											148		3	3	151
Apr. 12	60							170											230				230
Apr. 19	98							105	1	2									206				206
Apr. 26	202							66	14										282				282
May 3	329		18					21	3	22									393				393
May 10	329		150	1		7		51	9	34	3								584				584
May 17	155		218	7		95		16	21	17	20								549				549
May 24	55		115	10	31	209		3	13	9	41								486				486
May 31	34	3	97	46	291	94	8	10	8	7	20	30							648				648
June 7	23	29	23	75	322	33	76	5	7	2	6	63							664				664
June 14	15	39	13	64	208	17	157				17	109	7	3	2				651				651
June 21	12	22		24	61	7	120				16	22	21	111	2				418				418
June 28	8	11			15		37				29	1	12	98	2	12		3	228				228
July 5	7	10			2	4	4			1	63		1	19		15	1	7	134				134
Total	4097	122	725	234	942	615	540	604	76	94	215	225	41	231	6	27	1	17	8812	11	7	18	8830

TABLE VII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CABBAGE BY STATES FOR SEASON 1924-1925.

Week Ending	NEW CROP																										Total New Crop
	Fla.	Tex.	Cal.	S. C.	Va.	Ala.	Ga.	La.	Ariz.	Miss.	N. C.	Tenn.	Ark.	Md.	Ill.	Kan.	Ky.	Mo.	N. J.	Ohio	Okla.	Wash.	Iowa	N. Mex.	W. Va.	Other States	
Dec. 6	3	7	2	13	1																						26
Dec. 13	2	11		23	3																						39
Dec. 20	6	14	1	13	2																						36
Dec. 27	2	5	4	4	5																						20
Jan. 3	22	11	6	46	5																						90
Jan. 10	46	72	9	40	3																						170
Jan. 17	66	66	14	54	4																						204
Jan. 24	80	107	8	64	1																						260
Jan. 31	76	100	16	31	1	1																					225
Feb. 7	120	187	10	49	1	3																					370
Feb. 14	87	254	9	40		1																					391
Feb. 21	117	331	11	21		1	2																				483
Feb. 28	153	310	14	19		1	1																				498
Mar. 7	164	393	10	28		1	3																				599
Mar. 14	293	349	13				6																				661
Mar. 21	178	362	23	68		19	4	8																			662
Mar. 28	185	351	1	230		45	7	16																			835
Apr. 4	149	406	9	370		73	5	35	2	2																	1051
Apr. 11	44	222	11	527		178	2	50	4																	1	1039
Apr. 18	41	138	13	620		250	6	51	4		6																1129
Apr. 25	9	49	6	593		246	3	55	2	10	35																1008
May 2	2	9	12	393	13	198	4	55	1	76	76																839
May 9	11	9	25	353	90	111	3	98		218	77															1	996
May 16		5	63	163	355	73	5	85		142	59	1															951
May 23	2	3	75	18	313	38		53		138	58	13															711
May 30	5	1	16	3	301	7	1	24		55	19	54	6														492
June 6			10	2	300	5		18		18	4	127	3	40													527
June 13	1	1	31		120			9		1		73	3	67	2	8	3	23	9	3	1	1				1	357
June 20			41		27			8				42	2	99	16	19	13	46	17	45		2	2	4	2	3	388
June 27	1	2	15					4				9	4	27	20	13	9	27	4	98	1		18	5	5	3	265
Total	1865	3775	478	3785	1545	1251	52	569	13	660	334	319	18	233	38	40	25	96	30	146	2	3	20	9	7	9	15322

TABLE VII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CABBAGE BY STATES FOR SEASON 1924-1925.—Continued.

Week Ending	STORED CROP															Total Stored Crop	Total New & Stored Crop
	Colo.	Mich.	Minn.	N. Mex.	N. Y.	Ore.	Penna.	Utah	Wis.	Ill.	Me.	Mont.	Ohio	Wash.	Other States		
Dec. 6	14	5	21	1	475	2	9	1	196	28	2	1	2	1	1	759	785
Dec. 13	5	6	4	1	414	15	8		157	15	2				2	629	668
Dec. 20	2	2	2	1	260	6	4	1	73						2	353	389
Dec. 27				1	135		1		65		1				2	205	225
Jan. 3	5	3	1		372		5		187						11	584	674
Jan. 10	6	7	2		795		20		257		4			2	3	1096	1266
Jan. 17	6	2	6		424		34		166		1			2	2	643	847
Jan. 24	4	2	10		310		31		188					3	4	552	812
Jan. 31		3	3		219		14		127					2	3	371	596
Feb. 7	1	3	2		407		20		105					6	2	546	916
Feb. 14		8	3		424		16		65					3	1	520	911
Feb. 21		10	3		245		27		69					8	1	363	846
Feb. 28		7	1		93		9		33					3	2	148	646
Mar. 7		7	1		132		4		17						3	164	763
Mar. 14		3			172		11		5						46	237	898
Mar. 21		5			59		8		2							74	736
Mar. 28		6			54		1								28	89	924
Apr. 4					60		2								4	66	1117
Apr. 11					40											40	1079
Apr. 18					9											9	1138
Apr. 25																	1008
May 2																	839
May 9																	996
May 16																	951
May 23																	711
May 30																	492
June 6																	527
June 13																	357
June 20																	388
June 27																	265
Total	43	79	59	4	5099	23	224	2	1712	43	10	1	2	30	117	7448	22770

TABLE VIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CABBAGE BY STATES FOR SEASON 1925-1926.

	NEW CROP																											
	Domestic																											
Week Ending	Fla.	Cal.	S. C.	Texas	La.	Ala.	N. C.	Ga.	Miss.	Wash.	Ark.	Va.	Ariz.	N. Mex.	Okla.	Tenn.	Idaho	Md.	Wis.	Ill.	Colo.	Iowa	Kan.	Mo.	Other States	Total Domestic	Imports Cuba	Total Imports	Total New Crop
Dec. 5	2	1	1																							4			4
Dec. 12	1	2	2	3																						8			8
Dec. 19	5	1	7	8																						21			21
Dec. 26	15			12	1																					28			28
Jan. 2	10	8	9	2	1																					30			30
Jan. 9	9	42	28	26	3																					108			108
Jan. 16	24	35	15	45	10	1	1																			131			131
Jan. 23	13	39	30	56	7	3	1																			149			149
Jan. 30	31	19	38	45	6	2																				141			141
Feb. 6	29	20	21	151	3	4																				228			228
Feb. 13	45	43	10	206	3	2																				309			309
Feb. 20	43	39	7	335	5	5																				434			434
Feb. 27	66	28	11	453	3	9																				570	1	1	571
Mar. 6	82	20	6	424	2	6																				540	5	5	545
Mar. 13	91	18		457																						566	1	1	567
Mar. 20	137	47		245	2	13																				444	1	1	445
Mar. 27	200	42	5	916	1	21																				1185	1	1	1186
Apr. 3	151	21	2	662	2	22																				860	1	1	861
Apr. 10	224	2	27	641	2	39																				935			935
Apr. 17	194	33	187	449	7	61																				931			931
Apr. 24	97	17	313	270	13	89		1	2																	802			802
May 1	42	9	468	128	20	253		1	2																	923			923
May 8	24	21	548	127	46	342	6	5	72																1	1192			1192
May 15	5	19	480	80	62	355	21	3	176	1																1202			1202
May 22	1	12	321	18	30	193	53	4	233	8	1	16														890			890
May 29	1	6	189	6	39	98	80	8	372	17		158	1													975			975
June 5	1	8	29	2	17	28	49	7	131	15	4	314	12	2	1	30										650			650
June 12	1	13	9	3	9		37	11	26	8	7	335	13	11	4	256	2	6	1						3	755			755
June 19	1	1	13	11			20	3		5	3	238	7	14	1	210	2	39		2	2	1	10	12	9	604			604
Total	1545	566	2776	5781	294	1546	268	43	1014	54	15	1061	33	27	6	496	4	45	1	2	2	1	10	12	13	15615	10	10	15625

TABLE VIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CABBAGE BY STATES FOR SEASON 1925-1926.—Continued.

Week Ending	STORED CROP																		
	Domestic																		
	Colo.	Mich.	Minn.	Mont.	N. Mex.	N. Y.	Penna.	Utah	Wash.	Wis.	Ore.	Me.	Wyo.	Other States	Total Domestic	Imports Canada	Total Imports	Total Stored Crop	Total New and Stored Crop
Dec. 5	52	6	3	1	5	651	27	5	4	101				2	857			857	861
Dec. 12	57	3	4	3		468	9	6	3	110				3	666			666	674
Dec. 19	9		4			295	10		2	60				11	391			391	412
Dec. 26	5		1		1	209	6			90	1			3	316			316	344
Jan. 2	13		2		2	351	5			96	6			1	476			476	506
Jan. 9	20	3	10			773	23		1	195	20			13	1058			1058	1166
Jan. 16	14	9	5			586	26		6	157	37	2	1	15	858	3	3	861	992
Jan. 23	4	6	2			282	12		3	114	33	1	1	12	470			470	619
Jan. 30	1	11	2			221	14		1	89	21	1	1	8	370			370	511
Feb. 6		7	3			257	18		4	120	11		3	6	429			429	657
Feb. 13	2	7	1			236	10			72				12	340			340	649
Feb. 20	2	5	1			237	4			45				10	304			304	738
Feb. 27	4					120	3		5	14				7	153			153	724
Mar. 6	1					56	1		7	5				4	74			74	619
Mar. 13						33			1					28	62			62	629
Mar. 20						9								5	14			14	459
Mar. 27						4								1	5			5	1191
Apr. 3						7									7			7	868
Apr. 10																			935
Apr. 17																			931
Apr. 24																			802
May 1																			923
May 8																			1192
May 15																			1202
May 22																			890
May 29																			975
June 5																			650
June 12																			755
June 19																			604
Total	184	57	38	4	8	4795	168	11	37	1268	129	4	6	141	6850	3	3	6853	22478

TABLE IX.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CABBAGE BY STATES FOR SEASON 1926-1927.

Week Ending	NEW CROP												Total New Crop	STORED CROP											Total Stored Crop	Total New and Stored Crop
	Fla.	Texas	Cal.	S. C.	La.	Ala.	Ga.	Miss.	Ariz.	N. C.	Va.	Tenn.		Colo.	Minn.	N. Y.	Ore.	Penna.	Utah	Wash.	Wis.	Mich.	Ohio	Other States		
Dec. 11	1	13	1	3	......	......	......	......	......	......	......	......	18	13	1	603	4	18	3	3	196	......	......	9	850	868
Dec. 18	5	22	3	14	2	......	......	......	......	......	......	......	46	4	2	473	1	18	......	1	105	2	......	2	608	654
Dec. 25	5	70	6	3	1	......	......	......	......	......	......	......	85	5	5	293	......	9	1	4	141	......	......	......	458	543
Jan. 1	50	94	5	18	......	......	......	......	......	......	......	......	167	1	1	406	1	8	......	1	134	......	......	4	556	723
Jan. 8	34	148	3	12	3	......	......	......	......	......	......	......	200	2	3	625	......	15	1	5	145	1	6	5	808	1008
Jan. 15	35	206	10	13	8	......	......	......	......	......	......	......	272	3	......	531	5	19	1	4	153	3	......	2	721	993
Jan. 22	63	329	11	5	9	2	......	......	......	......	......	......	419	2	1	435	3	13	5	3	170	7	......	9	648	1067
Jan. 29	77	327	26	21	16	2	......	......	......	......	......	......	469	1	2	301	......	18	......	1	144	5	1	1	474	943
Feb. 5	64	268	18	11	19	1	......	......	......	......	......	......	381	1	1	303	......	14	......	2	79	7	......	......	407	788
Feb. 12	89	220	7	17	16	6	......	......	......	......	......	......	355	......	......	236	......	15	......	......	59	6	......	4	320	675
Feb. 19	111	322	14	20	20	19	3	1	......	......	......	......	510	......	......	172	......	8	......	2	34	4	......	3	223	733
Feb. 26	70	367	25	18	11	37	1	......	......	......	......	......	529	......	......	185	......	9	......	3	29	7	......	......	233	762
Mar. 5	103	567	21	5	13	59	2	......	......	......	......	......	770	......	......	190	......	4	......	2	25	8	......	1	230	1000
Mar. 12	71	767	29	......	......	80	......	......	......	......	......	......	947	......	......	236	......	8	......	2	8	6	......	21	281	1228
Mar. 19	75	376	15	2	12	58	2	......	1	......	......	......	541	......	......	114	......	4	......	......	......	6	......	22	146	687
Mar. 26	63	400	16	51	26	140	......	......	......	1	......	......	697	......	......	26	......	......	......	......	......	......	......	5	31	728
Apr. 2	43	447	15	296	41	286	3	......	......	1	......	......	1132	......	......	16	......	......	......	......	......	......	......	......	16	1148
Apr. 9	19	226	8	358	66	341	2	3	......	1	......	......	1024	......	......	14	......	......	......	......	......	......	......	3	17	1041
Apr. 16	4	77	1	242	48	288	1	21	......	7	......	......	689	......	......	16	......	......	......	......	......	......	......	......	16	705
Apr. 23	......	28	13	316	74	275	4	148	2	18	......	......	878	......	......	......	......	......	......	......	......	......	......	......	......	878
Apr. 30	2	12	11	267	62	159	14	264	......	36	2	......	829	......	......	......	......	......	......	......	......	......	......	......	......	829
May 7	5	8	24	150	42	51	6	128	3	58	68	......	543	......	......	......	......	......	......	......	......	......	......	......	......	543
May 14	5	11	24	41	16	6	6	65	......	36	201	......	411	......	......	......	......	......	......	......	......	......	......	......	......	411
May 21	1	6	21	......	3	......	2	39	2	29	371	5	479	......	......	......	......	......	......	......	......	......	......	......	......	479
Total	995	5311	327	1883	508	1810	46	669	8	187	642	5	12391	32	16	5175	14	180	11	33	1422	62	7	91	7043	19434

TABLE X.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CABBAGE BY STATES FOR SEASON 1927-1928.

Week Ending	NEW CROP														Total New Crop
	Fla.	Texas	S. C.	N. C.	Va.	Cal.	La.	Miss.	Ala.	Ariz.	Ga.	Ark.	Nev.	Tenn.	
Nov. 19	2	7	13	2											24
Nov. 26	1	11	10	1	1										24
Dec. 3	3	10	13	1											27
Dec. 10	5	10	27	1	3	1									47
Dec. 17	12	45	57	3		1	2								120
Dec. 24	6	18	8		1	3	3								39
Dec. 31	17	91	37		7		2								154
Jan. 7	25	175	16		9	5	2	2							234
Jan. 14	72	244	19		12	9	6								362
Jan. 21	81	344	9		5	7	5								451
Jan. 28	75	289	5			10	4								383
Feb. 4	65	341			2	6	3								417
Feb. 11	87	528				8	2								625
Feb. 18	70	642				10	1								723
Feb. 25	69	613				23									705
Mar. 3	62	576				13									651
Mar. 10	56	776				21									853
Mar. 17	54	729				74	4		3						864
Mar. 24	94	476				35	1		4	1					611
Mar. 31	61	463	1			18	6		7	2					558
Apr. 7	50	280	2			23	19		1						375
Apr. 14	57	203	33			44	46		14						397
Apr. 21	39	174	142		1	59	60	2	46		1				524
Apr. 28	29	78	280		1	53	68	5	99						613
May 5	10	30	367	10	1	60	67	115	156						816
May 12	6	17	427	24	17	73	43	258	169	1	3				1038
May 19	6	22	401	31	79	94	59	281	152	4					1129
May 26	2	42	288	49	205	40	63	228	118	4	5	4	1	1	1050
Total	1116	7234	2155	122	344	690	466	891	769	12	9	4	1	1	13814

TABLE X.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CABBAGE BY STATES FOR SEASON 1927-1928—Continued.

Week Ending	STORED CROP																				
	Colo.	Maine	Mich.	Minn.	Mont.	N. Y.	Ohio	Ore.	Penna.	Utah	Wash.	Wis.	Ill.	Ind.	N. J.	N. Mex.	Vt.	Wyo.	Other States	Total Stored Crop	Total New and Stored Crop
Nov. 19	11	4	9	19	1	840	17	1	43	12	2	170	3	1	1	3	1		3	1141	1165
Nov. 26	4		2	4		369	13	1	27	1	7	64		1		5			1	499	523
Dec. 3	1	1		3	2	295		4	12	2	4	84				2			2	412	439
Dec. 10				3		358		3	9		3	113							3	492	539
Dec. 17	2			5		378		6	3	2	3	157							4	560	680
Dec. 24	1					261		15	5			84							5	371	410
Dec. 31			1			370		7	6	2	1	95							1	483	637
Jan. 7			2	1		423			8	1	3	155								593	827
Jan. 14	1	5	7	6		792			11	2	7	226						1	3	1061	1423
Jan. 21	1		7	2		394			12		2	153							5	576	1027
Jan. 28			8	1		303			10		5	79							2	408	791
Feb. 4		1	4	1		282			5		2	83							1	379	796
Feb. 11		1	5			292			18		4	73							4	397	1022
Feb. 18			2			288			6		6	87							2	391	1114
Feb. 25			2			239			8		2	40							1	292	997
Mar. 3		1	3			215			4		5	21							5	254	905
Mar. 10		1				203			7		1	9							1	222	1075
Mar. 17		1	6			316			13		8	11							38	393	1257
Mar. 24			7			181			7		7								9	211	822
Mar. 31			6			66					3								6	81	639
Apr. 7			7			31					1									39	414
Apr. 14			5			39					1									45	442
Apr. 21			6			117													3	126	650
Apr. 28			5			66													3	74	687
May 5						30													2	32	848
May 12																					1038
May 19																			2	2	1131
May 26																					1050
Total	21	15	94	45	3	7148	30	37	214	22	77	1704	3	2	1	10	1	1	106	9534	23348

TABLE XI.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CABBAGE BY STATES FOR SEASON 1928-1929.

Week Ending	NEW CROP											Total New Crop	STORED CROP													Total Stored Crop	Total New and Stored Crop
	Fla.	Texas	Cal.	S. C.	La.	Va.	Ala.	Ga.	Miss.	N. C.	Ark.		Colo.	Maine	Mass.	Mich.	Minn.	N. Y.	Ore.	Penna.	Utah	Wash.	Wis.	Wyo.	Other States		
Dec. 15	3	21	1	16								41	5	1	1	8	2	354	13	6	3	3	150	2	6	554	595
Dec. 22	9	33	8	29	2	2						83	1			4	3	186	3	5		1	87	2		292	375
Dec. 29	17	41	5	12		2						77	3	2		5	5	369	1	1			154			540	617
Jan. 5	42	84	6	42	4	18	1					197		1		5	4	460		20			179		1	670	867
Jan. 12	59	169	14	31	7	9	2					291		3		8	9	457	2	18		5	165			667	958
Jan. 19	110	272	15	30	9	6	1					443				10	7	401		13		5	116	2		554	997
Jan. 26	162	345	13	36	9	5	5					575				3	3	397		8			52			463	1038
Feb. 2	211	270	7	10	13	3	2					516				4	2	126		9			51	1	2	195	711
Feb. 9	239	504	16	7	9	4	5					784				7	3	133		4			26			173	957
Feb. 16	281	442	15	5	7	3	5	2				760				8	1	118		5			12			144	904
Feb. 23	264	509	14	5	10	1	1	2				806				6		70		5			3			84	890
Mar. 2	327	581	8	3	4			5				928				4		64					1		1	70	998
Mar. 9	340	640	9	1	12	2		5	1			1010						30							1	81	1041
Mar. 16	358	708	16			1		5				1088				4		28							15	47	1135
Mar. 23	330	598	14	20	4		3	12	1			982				20									1	21	1003
Mar. 30	219	750	6	104	11		13	13	1			1117				5		3								8	1125
Apr. 6	54	365	3	313	15		47	5	3			805				3		1								4	809
Apr. 13	17	325	8	403	30		88	9	6	2		888				4										4	892
Apr. 20	6	425	18	659	69		160	14	40	9		1400				2		1								3	1403
Apr. 27	4	153	26	397	61		187	11	120	35		994				2		2								4	998
May 4	4	81	31	317	47	89	181	7	297	54		1108															1108
May 11	6	27	43	44	60	315	92	12	407	69		1075															1075
May 18	2	16	40	6	26	632	24	7	339	56	1	1149															1149
Total	3064	7359	336	2490	409	1092	817	109	1215	225	1	17117	9	7	1	112	39	3200	19	94	3	14	996	7	27	4528	21645

SUPPLEMENTAL DATA

TABLE XII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CABBAGE BY STATES AND IMPORTS FOR SEASON 1929-1930.

	NEW CROP															
	Domestic													Imports		
Week Ending	Fla.	Texas	Cal.	S. C.	Ariz.	Ala.	La.	Miss.	N. C.	Ark.	Tenn.	Va.	Other States	Total Domestic	Cuba	Total Imports	Total New Crop
Dec. 7	2	12	3	55										72			72
Dec. 14	6	26	3	88										123			123
Dec. 21	18	36	3	21										78			78
Dec. 28	30	41	9	12										92			92
Jan. 4	53	184	9	28										274			274
Jan. 11	93	328	9	13										443			443
Jan. 18	140	346	11	7										504			504
Jan. 25	112	51	18	8										189			189
Feb. 1	139	332	33	3										507			507
Feb. 8	98	262	34		2									396			396
Feb. 15	127	374	40											541			541
Feb. 22	148	518	45		4									715			715
Mar. 1	147	366	24		2									539			539
Mar. 8	143	371	31		6									551			551
Mar. 15	183	273	19											475			475
Mar. 22	275	294	18	7										594			594
Mar. 29	157	287	15	36										495	3	3	498
Apr. 5	154	291	26	75										546			546
Apr. 12	106	213	29	289										637			637
Apr. 19	79	238	51	408		9	3							788			788
Apr. 26	26	108	42	407		56	18	3	10					670			670
May 3	15	109	58	641		137	35	73	33					1101			1101
May 10	10	58	69	313		131	35	102	42	2				762			762
May 17	1	4	94	170		175	45	246	71	5	5	121	5	942			942
Total	2262	5122	693	2581	14	508	136	424	156	7	5	121	5	12034	3	3	12037

SUPPLEMENTAL DATA

TABLE XII.—Weekly Summary of Car-Lot Shipments of Cabbage by States and Imports for Season 1929-1930—Continued.

	STORED CROP												Total Stored Crop	Total New and Stored Crop
Week Ending	Colo.	Me.	Mich.	Minn.	N. Y.	Ore.	Penna.	Utah	Wash.	Wis.	Ohio	Other States		
Dec. 7	3	2	1	6	541	5	3	2	4	225		12	804	876
Dec. 14		2	4	6	483	5	15	1	3	205	1	8	733	856
Dec. 21		1	6	4	204	1	10	1		106		6	339	417
Dec. 28		2	3	4	276		2		1	105		5	398	490
Jan. 4		1	12	26	578	1	10			202		11	841	1115
Jan. 11			14	14	533		20		1	211		23	816	1259
Jan. 18			13	11	336		17		1	106		7	491	995
Jan. 25			6	4	291		8		3	71		11	394	583
Feb. 1			8	9	323		6		4	91		9	450	957
Feb. 8			7	2	234		7			56		6	312	708
Feb. 15			4	1	116		2			3			126	667
Feb. 22			3		59					2		4	68	783
Mar. 1					26							5	31	570
Mar. 8					11							1	12	563
Mar. 15														475
Mar. 22														594
Mar. 29														498
Apr. 5														546
Apr. 12														637
Apr. 19														788
Apr. 26														670
May 3														1101
May 10														762
May 17														842
Total	3	8	81	87	4011	12	100	4	17	1383	1	108	5815	17852

TABLE XIII. — WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CELERY BY STATES FOR 1925.

Week Ending	NEW CROP				Total New Crop	STORED CROP			Total Stored Crop	Total New and Stored Crop
	Fla.	Cal.	La.	Mich.		N. Y.	Mich.	Other States		
Jan. 3	9	214			223	201		1	202	425
Jan. 10	118	352			470	194	2	1	197	667
Jan. 17	204	273			477	72			72	549
Jan. 24	303	157			460	27			27	487
Jan. 31	304	91			395	4			4	399
Feb. 7	331	81			412	5			5	417
Feb. 14	394	83			477					477
Feb. 21	491	106			597	1			1	598
Feb. 28	566	87			653					653
Mar. 7	419	104			523					523
Mar. 14	442	89			531					531
Mar. 21	589	86			675					675
Mar. 28	562	67			629					629
Apr. 4	374	22			396					396
Apr. 11	483	10			493					493
Apr. 18	420				420					420
Apr. 25	409	18			427					427
May 2	405	39			444					444
May 9	419	57			476					476
May 16	278	35			313					313
May 23	138	39			177					177
May 30	122	50			172					172
June 6	70	54			124					124
June 13	31	47			78					78
June 20	5	40	1	1	47					47
Total	7886	2201	1	1	10089	504	2	2	508	10597

TABLE XIV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CELERY BY STATES AND IMPORTS FOR 1926.

	NEW CROP								STORED CROP				
	DOMESTIC					Imports							
Week Ending	Fla.	Cal.	Mich.	N. Y.	Total Domestic	Bermuda	Total Imports	Total New Crop	Mich.	N. Y.	Other States	Total Stored Crop	Total New and Stored Crop
Jan. 16	36	540			576			576	4	162	1	167	743
Jan. 23	100	278			378			378	2	93		95	473
Jan. 30	73	164			237			237		45		45	282
Feb. 6	152	52			204			204		7	1	8	212
Feb. 13	179	148			327			327					327
Feb. 20	267	107			374			374			1		375
Feb. 27	368	173			541			541					541
Mar. 6	353	131			484			484					484
Mar. 13	281	109			390			390					390
Mar. 20	442	69			511			511					511
Mar. 27	441	32			473			473					473
Apr. 3	473	40			513			513					513
Apr. 10	478	8			486			486					486
Apr. 17	675	25			700			700					700
Apr. 24	424	38			462			462					462
May 1	180	64			244			244					244
May 8	115	21			136			136					136
May 15	105	13			118			118					118
May 22	96	26			122			122					122
May 29	127	73			200			200					200
June 5	42	69			111			111					111
June 12	19	66			85			85					85
June 19		75			75	14	14	89					89
June 26	1	93	3	3	100			100					100
Total	5427	2414	3	3	7847	14	14	7861	6	307	3	316	8177

TABLE XV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CELERY BY STATES AND IMPORTS FOR 1927.

	NEW CROP								STORED CROP				
	DOMESTIC					Imports							
Week Ending	Fla.	Cal.	N. Y.	Texas	Total Domestic	Bermuda	Total Imports	Total New Crop	Mich.	N. Y.	Other States	Total Stored Crop	Total New and Stored
Jan. 8	23	432			455			455	17	246		263	718
Jan. 15	143	727			870			870	10	152		162	1032
Jan. 22	217	516			733			733	11	92		103	836
Jan. 29	301	399			700			700	8	29		37	737
Feb. 5	357	195			552			552	3	15		18	570
Feb. 12	413	118			531			531	1	1		2	533
Feb. 19	492	34			526			526	1			1	527
Feb. 26	492	271			763			763			1	1	764
Mar. 5	501	195			696			696			1	1	697
Mar. 12	561	183			744			744					744
Mar. 19	724	247			971			971					971
Mar. 26	557	143			700			700					700
Apr. 2	386	74			460			460					460
Apr. 9	430	98			528			528					528
Apr. 16	427	81			508			508					508
Apr. 23	301	46			347			347					347
Apr. 30	191	96			287			287					287
May 7	199	162			361	1	1	362					362
May 14	159	120			279			279					279
May 21	110	75			185	13	13	198					198
May 28	127	46			173	42	42	215					215
June 4	54	38			92	38	38	130					130
June 11	32	57	1		90	56	56	146					146
June 18	7	85		1	93	32	32	125					125
Total	7204	4438	1	1	11644	182	182	11826	51	535	2	588	12414

TABLE XVI. WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CELERY BY STATES AND IMPORTS FOR SEASON 1927-1928.

	NEW CROP							STORED CROP					
	Domestic				Imports								
Week Ending	Fla.	Cal.	Mich.	Total Domestic	Bermuda	Total Imports	Total New Crop	Mich.	N. Y.	Utah	Other States	Total Stored	Total New and Stored Crop
Dec. 17	4	447		451			451	19	478	1	2	500	951
Dec. 24	2	365		367			367	15	269		1	285	652
Dec. 31	17	219		236			236	8	258			266	502
Jan. 7	57	575		632			632	5	223		1	229	861
Jan. 14	174	779		953			953	1	181		3	185	1138
Jan. 21	251	463		714			714		62		2	64	778
Jan. 28	250	434		684			684		37		1	38	722
Feb. 4	319	247		566			566		12		2	14	580
Feb. 11	466	176		642			642						642
Feb. 18	447	175		622			622				2	2	624
Feb. 25	633	142		775			775				1	1	776
Mar. 3	533	139		672			672						672
Mar. 10	557	176		733			733						733
Mar. 17	616	209		825			825						825
Mar. 24	541	211		752			752						752
Mar. 31	513	93		606			606						606
Apr. 7	404	99		503			503						503
Apr. 14	490	95		585	1	1	586						586
Apr. 21	494	49		543	4	4	547						547
Apr. 28	329	83		412	10	10	422						422
May 5	378	195		573	16	16	589						589
May 12	270	149		419	27	27	446						446
May 19	162	88		250	41	41	291						291
May 26	146	128		274	44	44	318						318
June 2	126	139		265	42	42	307						307
June 9	153	110		263	48	48	311						311
June 16	32	101		133	16	16	149						149
June 23	5	120	1	126			126						126
Total	8369	6206	1	14576	249	249	14825	48	1520	1	15	1584	16409

TABLE XVII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CELERY BY STATES AND IMPORTS FOR 1929.

	NEW CROP									STORED CROP								
	Domestic						Imports			Domestic					Imports			
Week Ending	Fla.	Cal.	Ore.	Md.	Mich.	Total Domestic	Bermuda	Total Imports	Total New Crop	N. Y.	Ohio	Utah	Other States	Total Domestic	Canada	Total Imports	Total Stored Crop	Total New and Stored Crop
Jan. 12	11	731				742			742	100	2	1		103			103	845
Jan. 19	126	541				667			667	50	1			51			51	718
Jan. 26	261	470				731			731	35	1			36			36	767
Feb. 2	381	317				698			698	19			1	20			20	718
Feb. 9	449	153				602			602	4				4			4	606
Feb. 16	645	252				897			897	1			1	2	1	1	3	900
Feb. 23	720	183				903			903									903
Mar. 2	685	195				880			880	1			1	2			2	882
Mar. 9	646	177				823			823	1			1	2			2	825
Mar. 16	55	144				199			199									199
Mar. 23	955	106				1061			1061									1061
Mar. 30	756	101				857			857				3	3			3	860
Apr. 6	569	120				689			689									689
Apr. 13	631	163				794	1	1	795									795
Apr. 20	388	78				466	2	2	468									468
Apr. 27	313	26				339	3	3	342									342
May 4	434	149				583	15	15	598									598
May 11	408	219				627	20	20	647									647
May 18	212	99				311	50	50	361									361
May 25	139	116				255	46	46	301									301
June 1	51	113				164	55	55	219									219
June 8	23	110				133	73	73	206									206
June 15	6	111				117	7	7	124									124
June 22	4	208	1			213	12	12	225									225
June 29	3	116	2	1	19	141	2	2	143									143
Total	8871	4998	3	1	19	13892	286	286	14178	211	4	1	7	223	1	1	224	14402

SUPPLEMENTAL DATA

TABLE XVIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CELERY BY STATES AND IMPORTS FOR SEASON 1929-1930.

Week Ending	NEW CROP								STORED CROP						Total New and Stored Crop
	Domestic				Total Domestic	Imports		Total New Crop	Mich.	N. Y.	Ohio	Utah	Other States	Total Stored Crop	
	Fla.	Cal.	La.	Mich.		Bermuda	Total Imports								
Dec. 21	32	566			598			598	14	140	2	1	8	165	763
Dec. 28	35	479			514			514	3	103			1	107	621
Jan. 4	166	480			646			646	4	52				56	702
Jan. 11	237	383			620			620		28	1		4	33	653
Jan. 18	350	352			702			702		21				21	723
Jan. 25	325	365			690			690		10	1		3	14	704
Feb. 1	340	177			517			517		8	1			9	526
Feb. 8	522	171			693			693		1				1	694
Feb. 15	652	189			841			841		1				1	842
Feb. 22	643	136			779			779							779
Mar. 1	782	153			935			935					1	1	936
Mar. 8	474	115			589			589							589
Mar. 15	508	142			650			650							650
Mar. 22	661	133			794			794							794
Mar. 29	497	138			635			635							635
Apr. 5	547	100			647			647							647
Apr. 12	720	24			744	3	3	747					3	3	750
Apr. 19	441				441	12	12	453							453
Apr. 26	406	186			592	13	13	605							605
May 3	350	209			559	24	24	583							583
May 10	419	177			596	23	23	619							619
May 17	207	108			315	25	25	340							340
May 24	211	145			356	27	27	383							383
May 31	160	210			370	17	17	387							387
June 7	112	201			313	11	11	324							324
June 14	21	183			204			204							204
June 21	6	204	1	5	216	12	12	228							228
Total	9824	5726	1	5	15556	167	167	15723	21	364	5	1	20	411	16134

TABLE XIX.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CUCUMBERS BY STATES FOR 1925.

Week Ending	DOMESTIC													Total Domestic
	Fla.	Ind.	Ill.	Ohio	La.	Texas	Ala.	Ga.	Cal.	S. C.	Va.	Ark.	N. C.	
SPRING														
Mar. 21	17	1												18
Mar. 28	57	2	1											60
Apr. 4	92	2	1											95
Apr. 11	101	3	2											106
Apr. 18	90	2	1	3										96
Apr. 25	181	4	1	10	2	11								209
May 2	256	5		12		15								288
May 9	304	2	2	5		10								323
May 16	193	3	2	10		18	11							237
May 23	231	3	1	10		9	59	2						315
May 30	218	1	1	10	1	4	176	22	2	54	1			490
June 6	67	4	1	13		1	265	25		166	4	2	2	550
June 13	10	4	1	6			137	11		204	5	7	108	493
Total	1817	36	14	79	3	68	648	60	2	424	10	9	110	3280

Week Ending	DOMESTIC													Total Domestic
	Fla.	N. Y.	Other States											
FALL														
Oct. 17	8		3											11
Oct. 24	24	1	5											30
Oct. 31	13		2											15
Nov. 7	11		2											13
Total	56	1	12											69

TABLE XX.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CUCUMBERS BY STATES FOR 1926.

	DOMESTIC														
Week Ending	Fla.	Ill.	Ohio	Texas	Ind.	Ga.	Ala.	Cal.	La.	Miss.	S. C.	Va.	Ark.	N. C.	Total Domestic
Apr. 10	5	3													8
Apr. 17	49	1													50
Apr. 24	66	3	7	1											77
May 1	187	1	6	6	4										204
May 8	244	1	11	47	4	1									308
May 15	319	1	13	118	7										458
May 22	385	3	12	94	8		1	11	4	1					519
May 29	461	2	15	35	3	3	73	9	6		1				608
June 5	246	1	14	3	6	12	268	8	7		28	1			594
June 12	52		13		6	22	181	6	4	2	109	2			397
June 19	14	1	16	1	8	16	70	14	2	1	190	4	8	21	366
June 26	3	1	12	1	4	5	29	4	4	1	228	6	28	165	491
Total	2031	18	119	306	50	59	622	52	27	5	556	13	36	186	4080

TABLE XXI—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CUCUMBERS BY STATES AND IMPORTS FOR 1927.

Week Ending	Domestic											Total Domestic
	Fla.	Ind.	Ohio	Ill.	Texas	Ala.	Ga.	S. C.	La.	Miss.	Va.	
SPRING												
Mar. 19	4	6										10
Mar. 26	40	5										45
Apr. 2	113	4										117
Apr. 9	274	2										276
Apr. 16	272	2	5									279
Apr. 23	281	5	11	1	1							299
Apr. 30	189	7	14	2	11							223
May 7	498	6	13	1	72	5						595
May 14	319	5	17	3	62	75	4					485
May 21	187	8	14	1	33	134	10	5				392
May 28	76	6	18		36	211	17	41				405
June 4	6	6	20	3	2	88	18	131	2	2	1	279
Total	2259	62	112	11	217	513	49	177	2	2	1	3405

Week Ending	Domestic		Total Domestic	Imports	Total Imports	Total All Sources
	Fla.	Cal.		Cuba		
FALL						
Nov. 5	7	2	9			9
Nov. 12	6	4	10			10
Nov. 19	16	9	25			25
Nov. 26	6	8	14			14
Dec. 3	8	5	13	1	1	14
Total	43	28	71	1	1	72

TABLE XXII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CUCUMBERS BY STATES AND IMPORTS FOR 1928.

Week Ending	DOMESTIC Fla.	Ill.	Ind.	Ohio	Texas	La.	Ala.	Cal.	S. C.	Va.	Ga.	Ark.	N. C.	Total Domestic	Imports Mexico	Total Imports	Total All Sources
SPRING																	
Mar. 31	6	1	5											12			12
Apr. 7	15	1	4											20			20
Mar. 14	67	2	6											75	1	1	76
Apr. 21	136	3	3	3										145			145
Apr. 28	245	3	3	5										256			256
May 5	141	1	4	6										152			152
May 12	182	1	4	17	1									205			205
May 19	180	2	3	17	58	4								264			264
May 26	159	1	6	26	131	8	20	4						355			355
June 2	130	2	7	21	82	5	153	2	4	1				407			407
June 9	46	4	5	18	73	3	191	4	76	2	11			433			433
June 16	3	4	6	17	25	3	174	3	270	6	35	4	4	554			554
Total	1310	25	56	130	370	23	538	13	350	9	46	4	4	2878	1	1	2879

Week Ending	DOMESTIC Fla.	Cal.	Total Domestic
FALL			
Nov. 3	11	3	14
Nov. 10	16	7	23
Nov. 17	15	11	26
Nov. 24	18	6	24
Dec. 1	8	1	9
Dec. 8	11	1	12
Total	79	29	108

TABLE XXIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CUCUMBERS BY STATES AND IMPORTS FOR 1929.

Week Ending	DOMESTIC Fla.	Ill.	Ind.	Ohio	Texas	La.	Ala.	Ga.	S. C.	Va.	Total Domestic	Imports Cuba	Total Imports	Total All Sources
SPRING														
Feb. 16	3	3									6	2	2	8
Feb. 23	1	4	5								10	3	3	13
Mar. 2	1	3	1								5	4	4	9
Mar. 9		3	2								5	3	3	8
Mar. 16	12	2	5								19			19
Mar. 23	108	2	2								112			112
Mar. 30	284	3	3								290			290
Apr. 6	244	4	2								250			250
Apr. 13	251	3	4	1							259			259
Apr. 20	204	5	6		1						216			216
Apr. 27	351	2	5	2	83	2					445			445
May 4	302	1	5	15	114	4	12				453			453
May 11	199	2	5	14	34	3	145	3	1		406			406
May 18	108	1	8	16	13	2	257	18	12	1	436			436
May 20	14	3	5	12	7		155	48	106	2	352			352
June 1	2	2	7	11	10	3	173	41	316	3	568			568
Total	2084	43	65	71	262	14	742	110	435	6	3832	12	12	3844

Week Ending	DOMESTIC Fla.	Cal.	La.	Other States	Total Domestic	IMPORTS Cuba	Mexico	Porto Rico	Total Imports	Total All Sources
FALL										
Oct. 19	2	6	27	3	38					38
Oct. 26	1	7	8	1	17					17
Nov. 2	5	5		5	15					15
Nov. 9	12	5		1	18					18
Nov. 16	23	3		1	27					27
Nov. 23	23	3			26					26
Nov. 30	44				44	2	1		3	47
Dec. 7	27				27	3			3	30
Dec. 14	16				16	3		1	4	20
Dec. 21	7			1	8	6		2	8	16
Total	160	29	35	12	236	14	1	3	18	254

SUPPLEMENTAL DATA

TABLE XXIV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CUCUMBERS BY STATES AND IMPORTS, 1930.

Week Ending	DOMESTIC															Total Domestic	Imports Cuba	Total Imports	Total All Sources
	Fla.	Ill.	Ind.	Iowa	Ohio	Texas	Ala.	La.	Cal.	Ga.	S. C.	Miss.	Va.	Ark.	N. C.				
SPRING																			
Mar. 22	3	4														7	3	3	10
Mar. 29	6	1	1													8	2	2	10
Apr. 5	25	4	1													30			30
Apr. 12	72	2	2	2	2											80			80
Apr. 19	50	2	3	2	4											61			61
Apr. 26	40	3	1	1	8	10										63			63
May 3	31	2	2	1	15	183										234			234
May 10	58	3	3	1	19	271	2	2								359			359
May 17	242	3		1	18	242	71	3	1							581			581
May 24	203	4		1	11	80	201		4	1	4					509			509
May 31	63	4	1	2	16	19	338	14		37	142	9	2			647			647
June 7	32	2	2	3	10	31	191	33	1	56	441	24	5	4		835			835
June 14	8	3			8	13	46	21		25	327	28	5	29	35	548			548
Total	833	37	16	14	111	849	849	73	6	119	914	61	12	33	35	3962	5	5	3967

Week Ending	DOMESTIC								Other States	Total Domestic
	Fla.	Cal.	Ga.	La.	Mich.	N. Y.	Texas	Wash.		
FALL										
Oct. 11	1	5	3	17	5	8			3	42
Oct. 18	3	2	2	12	1				4	24
Oct. 25	24	7		7			5		3	46
Nov. 1	48	3					3	1	3	58
Nov. 8	49	2							3	54
Nov. 15	56	4							1	61
Nov. 22	59	1								60
Nov. 29	36								1	37
Dec. 6	13									13
Dec. 13	5								1	6
Total	294	24	5	36	6	8	8	1	19	401

TABLE XXV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF EGGPLANTS BY STATES AND IMPORTS FOR SEASON 1925-1926.

Week Ending	Domestic			Total Domestic	Imports	Total Imports	Total All Sources
	Fla.	S. C.	Va.		Bermuda		
SPRING							
Apr. 25	9			9			9
May 2	20			20			20
May 9	16			16	2	2	18
May 16	31			31			31
May 23	34			34			34
May 30	28			28			28
June 6	29			29			29
June 13	11			11			11
June 20	10			10			10
June 27	10			10			10
July 4	8	2		10			10
July 11	3	4	4	11			11
July 18	4	6	4	14			14
July 25	2	6	6	14			14
Total	215	18	14	247	2	2	249

Week Ending	Domestic		Total Domestic	Imports	Total Imports	Total All Sources	
	Fla.	Texas		Cuba			
FALL							
Oct. 31	2	1	3			3	
Nov. 7	7	1	8			8	
Nov. 14	7	1	8			8	
Nov. 21	9	1	10			10	
Nov. 28	3		3			3	
Dec. 5	8		8			8	
Dec. 12	2		2	1	1	3	
Dec. 19				2	2	2	
Dec. 26	1		1	5	5	6	
Jan. 2	2		2	5	5	7	
Total	41	4	45	13	13	58	

TABLE XXVI.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF EGGPLANTS BY STATES AND IMPORTS FOR SEASON 1926-1927.

Week Ending	Domestic					Total Domestic	
	Fla.	Va.	Miss.	S. C.	La.		
SPRING							
June 5	1					1	
June 12	8					8	
June 19	4					4	
June 26	4					4	
July 3	3					3	
July 10	7	2				9	
July 17	7	1	1	1		10	
July 24	3	1		2		6	
July 31	3	1		5	1	10	
Total	40	5	1	8	1	55	

Week Ending	Domestic			Total Domestic	Imports	Total Imports	Total All Sources
	Fla.	Texas	Other States		Cuba		
FALL							
Oct. 16	2			2			2
Oct. 23	4			4			4
Oct. 30	5	1		6			6
Nov. 6	4	2		6			6
Nov. 13	8	2		10			10
Nov. 20	3	2		5			5
Nov. 27							
Dec. 4	2			2			2
Dec. 11	1		1	2			2
Dec. 18	1			1			1
Dec. 25					4	4	4
Jan. 1	3			3	7	7	10
Jan. 8					8	8	8
Jan. 15	2			2	7	7	9
Total	35	7	1	43	26	26	69

TABLE XXVII—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF EGGPLANTS BY STATES AND IMPORTS FOR SEASON 1927-1928.

Week Ending	Domestic				Total Domestic	Imports		Total Imports	Total All Sources
	Fla.	La.	S. C.	Va.		Cuba	Porto Rico		
SPRING									
Mar. 26	1	....	....	....	1	18	3	21	22
Apr. 2	4	....	....	....	4	22	....	22	26
Apr. 9	3	....	....	....	3	22	3	25	28
Apr. 16	3	....	....	....	3	21	2	23	26
Apr. 23	5	....	....	....	5	12	1	13	18
Apr. 30	5	....	....	....	5	15	....	15	20
May 7	9	....	....	....	9	6	....	6	15
May 14	6	....	....	....	6	5	....	5	11
May 21	17	....	....	....	17	7	....	7	24
May 28	14	....	....	....	14	4	....	4	18
June 4	6	....	....	....	6	1	....	1	7
June 11	17	....	....	....	17	....	....	....	17
June 18	17	....	....	....	17	....	....	....	17
June 25	24	....	....	....	24	....	....	....	24
July 2	17	1	2	....	20	....	....	....	20
July 9	17	....	2	2	21	....	....	....	21
July 16	15	1	3	7	26	....	....	....	26
July 23	9	....	5	9	23	....	....	....	23
July 30	7	....	2	21	30	....	....	....	30
Total	196	2	14	39	251	133	9	142	393

TABLE XXVII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF EGGPLANTS BY STATES AND IMPORTS FOR SEASON 1927-1928—(Continued).

Week Ending	Domestic		Total Domestic	Imports		Total Imports	Total All Sources
	Fla.	Texas		Cuba	Porto Rico		
FALL							
Oct. 15	1	....	1	....	....	....	1
Oct. 22	5	2	7	....	....	....	7
Oct. 29	5	2	7	....	....	....	7
Nov. 5	10	4	14	....	....	....	14
Nov. 12	7	1	8	....	....	....	8
Nov. 19	9	4	13	....	....	....	13
Nov. 26	5	3	8	....	....	....	8
Dec. 3	6	....	6	....	....	....	6
Dec. 10	4	1	5	....	....	....	5
Dec. 17	6	....	6	....	....	....	6
Dec. 24	3	....	3	....	....	....	3
Dec. 31	3	....	3	11	....	11	14
Jan. 7	2	....	2	....	....	....	2
Jan. 14	....	....	....	15	....	15	15
Jan. 21	1	....	1	23	....	23	24
Jan. 28	3	....	3	24	....	24	27
Feb. 4	1	....	1	28	....	28	29
Feb. 11	....	....	....	21	....	21	21
Feb. 18	1	....	1	24	1	25	26
Total	72	17	89	146	1	147	236

TABLE XXVIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF EGG-PLANTS BY STATES AND IMPORTS FOR 1928.

Week Ending	Domestic		Total Domestic	Imports	Total Imports	Total All Sources
	Fla.	Va.		Cuba		
Mar. 31	4	....	4	17	17	21
Apr. 7	2	....	2	13	13	15
Apr. 14	10	....	10	9	9	19
Apr. 21	6	....	6	11	11	17
Apr. 28	5	....	5	9	9	14
May 5	1	....	1	6	6	7
May 12	2	....	2	3	3	5
May 19	4	....	4	1	1	5
May 26	6	....	6	1	1	7
June 2	3	....	3	....	....	3
June 9	9	....	9	....	....	9
June 16	13	....	13	....	....	13
June 23	10	....	10	....	....	10
June 30	17	....	17	....	....	17
July 7	10	5	15	....	....	15
July 14	8	11	19	....	....	19
July 21	3	15	18	....	....	18
Total	113	31	144	70	70	214

TABLE XXIX.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF EGGPLANTS BY STATES AND IMPORTS FOR SEASON 1929-1930.

Week Ending	Domestic		Total Domestic	Imports Cuba	Total Imports	Total All Sources
	Fla.	Va.				
SPRING						
Mar. 9	2		2	37	37	39
Mar. 16	1		1	31	31	32
Mar. 23	4		4	27	27	31
Mar. 30	7		7	25	25	32
Apr. 6	15		15	19	19	34
Apr. 13	12		12	22	22	34
Apr. 20	9		9	16	16	25
Apr. 27	6		6	17	17	23
May 4	15		15	12	12	27
May 11	12		12	8	8	20
May 18	29		29	6	6	35
May 25	19		19	3	3	22
June 1	17		17			17
June 8	14		14			14
June 15	17		17			17
June 22	3		3			3
June 29	8	4	12			12
July 6	4	5	9			9
Total	194	9	203	223	223	426

TABLE XXIX.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF EGGPLANTS BY STATES AND IMPORTS FOR SEASON 1929-1930—(Continued).

Week Ending	Domestic		Total Domestic	Imports		Total Imports	Total All Sources
	Fla.	Texas		Cuba	Porto Rico		
FALL							
Oct. 5	2	1	3				3
Oct. 12	1	1	2				2
Oct. 19	4	1	5				5
Oct. 26	8	1	9				9
Nov. 2	7	4	11				11
Nov. 9	15	4	19				19
Nov. 16	14	6	20				20
Nov. 23	10		10				10
Nov. 30	9		9	1		1	10
Dec. 7	2		2	1		1	3
Dec. 14				6		6	6
Dec. 21	1		1	10		10	11
Dec. 28				14		14	14
Jan. 4				13		13	13
Jan. 11	1		1	20	1	21	22
Jan. 18	2		2	17	1	18	20
Jan. 25	2		2	20	1	21	23
Feb. 1	1		1	21	1	22	23
Total	79	18	97	123	4	127	224

SUPPLEMENTAL DATA

TABLE XXX.—Weekly Summary of Car-Lot Shipments of Eggplants by States and Imports for Season 1930-1931.

Week Ending	Domestic		Total Domestic	Imports	Total Imports	Total All Sources
	Fla.	Va.		Cuba		
SPRING						
Mar. 29	1		1	12	12	13
Apr. 5	3		3	9	9	12
Apr. 12	1		1	9	9	10
Apr. 19	2		2	7	7	9
Apr. 26	4		4	4	4	8
May 3	3		3	9	9	12
May 10	11		11	3	3	14
May 17	12		12	2	2	14
May 24	13		13			13
May 31	14		14			14
June 7	25		25			25
June 14	18		18			18
June 21	8		8			8
June 28	10	3	13			13
July 5	5	8	13			13
Total	130	11	141	55	55	196

SUPPLEMENTAL DATA

TABLE XXX.—Weekly Summary of Car-Lot Shipments of Eggplants by States and Imports for Season 1930-1931—(Continued).

Week Ending	Domestic		Total Domestic	Imports		Total Imports	Total All Sources
	Fla.	Texas		Cuba	Porto Rico		
FALL							
Oct. 11	1		1				1
Oct. 18	10		10				10
Oct. 25	15		15				15
Nov. 1	18		18				18
Nov. 8	16		16				16
Nov. 15	21		21				21
Nov. 22	20	1	21				21
Nov. 29	11		11	2		2	13
Dec. 6	3	1	4	3		3	7
Dec. 13	1	1	2	6		6	8
Dec. 20	1	1	2	2		2	4
Dec. 27	2		2	12		12	14
Jan. 3	1		1	19		19	20
Jan. 10	1		1	16		16	17
Jan. 17	1		1	6		6	7
Jan. 24	1		1	16		16	17
Jan. 31	2		2	17	1	18	20
Feb. 7	1		1	16	1	17	18
Total	126	4	130	115	2	117	247

TABLE XXXI.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF LETTUCE BY STATES AND IMPORTS FOR SEASON 1924-1925.

Week Ending	DOMESTIC																Total Domestic	Imports	Total Imports	Total all Sources
	Fla.	Cal.	Idaho	N. J.	Ore.	Va.	Wash.	N. Y.	Ariz.	Texas	S. C.	Ga.	Ohio	N. C.	La.	Other States		Mexico		
Nov. 15	4	411	55	69	11	12	6	1	....	....	....	....	....	....	....	11	580	....	....	580
Nov. 22	49	564	15	5	2	13	2	....	2	....	....	....	....	....	....	13	665	....	....	665
Nov. 29	97	508	....	....	....	....	....	....	10	....	....	....	....	....	....	....	615	....	....	615
Dec. 6	117	498	....	....	....	....	....	....	27	....	....	....	....	....	....	....	642	....	....	642
Dec. 13	299	337	....	....	....	....	....	....	121	....	....	....	....	....	....	....	757	....	....	757
Dec. 20	178	289	....	....	....	....	....	....	120	....	....	....	....	....	....	....	587	....	....	587
Dec. 27	65	201	....	....	....	....	....	....	231	....	....	....	....	....	....	....	497	3	3	500
Jan. 3	79	286	....	....	....	....	....	....	250	....	....	....	....	....	....	....	615	....	....	615
Jan. 10	85	467	....	....	....	....	....	....	222	....	....	....	....	....	....	....	774	....	....	774
Jan. 17	134	405	....	....	....	....	....	....	199	....	....	....	....	....	....	....	738	....	....	738
Jan. 24	103	464	....	....	....	....	....	....	164	5	....	....	....	....	....	....	736	....	....	736
Jan. 31	79	470	....	....	....	....	....	....	120	5	....	....	....	....	....	....	674	....	....	674
Feb. 7	47	530	....	....	....	....	....	....	110	10	1	....	....	....	....	....	698	1	1	699
Feb. 14	52	683	....	....	....	....	....	....	72	15	1	....	....	....	....	....	823	8	8	831
Feb. 21	77	766	....	....	....	....	....	....	47	30	....	5	2	....	....	....	927	3	3	930
Feb. 28	114	571	....	....	....	....	....	....	35	20	4	7	....	....	....	....	751	....	....	751
Mar. 7	118	679	....	....	....	....	....	....	64	13	10	4	3	....	....	....	891	1	1	892
Mar. 14	111	655	....	....	....	....	....	....	37	8	31	3	5	....	....	....	850	1	1	851
Mar. 21	119	952	....	....	....	....	....	....	32	8	95	1	4	4	....	....	1215	1	1	1216
Mar. 28	38	1353	....	....	....	1	....	....	23	3	130	1	4	2	1	....	1556	....	....	1556
Apr. 4	8	1062	....	....	....	1	....	....	32	....	124	1	7	1	....	....	1236	....	....	1236
Apr. 11	11	472	....	....	....	....	....	....	57	....	111	....	10	2	1	....	664	....	....	664
Apr. 18	1	305	....	2	....	....	....	....	246	....	126	....	11	24	2	1	718	....	....	718
Total	1985	12928	70	76	13	27	8	1	2221	117	633	22	46	33	4	25	18209	18	18	18227

TABLE XXXII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF LETTUCE BY STATES AND IMPORTS FOR SEASON 1925-1926.

	DOMESTIC																	Imports		
Week Ending	Fla.	Cal.	Colo.	Idaho	N. J.	Ore.	Va.	Wash.	N. Y.	Ariz.	Nev.	Texas	Ohio	Ga.	La.	S. C.	Other States	Total Domestic	Mexico	Total Imports	Total all Sources
Nov. 7	2	445	7	88	37	2	10	2									1	594			594
Nov. 14	8	406		49	45	3	7	2									4	524			524
Nov. 21	14	479		43	47	1	5	4	1								3	597			597
Nov. 28	24	360		20	36	1	4			23							1	469			469
Dec. 5	43	441		21	25					154							8	692			692
Dec. 12	50	275		6	10					383	4	1					2	731			731
Dec. 19	49	314								417	3	2						785			785
Dec. 26	27	307								202	1	1						538			538
Jan. 2	11	559								403	2	1						976			976
Jan. 9	26	818								328		2						1174			1174
Jan. 16	33	721								319		1						1074	1	1	1075
Jan. 23	49	645								41			1					736			736
Jan. 30	25	858								35		1	1					920	3	3	923
Feb. 6	28	850								48		4	1					931	1	1	932
Feb. 13	11	682								63		9						765	6	6	771
Feb. 20	21	703								40		17	1					782	4	4	786
Feb. 27	12	992								41		13	2					1060	1	1	1061
Mar. 6	13	992								41		6	3					1055			1055
Mar. 13	17	703								46		10	4					780	1	1	781
Mar. 20	20	703								42		4	3					772			772
Mar. 27	48	731								40		11	5	1				836			836
Apr. 3	51	871								186		2	4	8	1	4		1127			1127
Apr. 10	15	194					2			303		2	6	14	1	35		572			572
Total	597	14049	7	227	200	7	28	8	1	3155	10	87	31	23	2	39	19	18490	17	17	18507

TABLE XXXIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF LETTUCE BY STATES AND IMPORTS FOR SEASON 1926-1927.

Week Ending	DOMESTIC																Imports		
	Fla.	Cal.	Idaho	N. J.	Va.	Wash.	Ore.	Nev.	Ariz.	Texas	Ohio	S. C.	Ga.	La.	Other States	Total Domestic	Mexico	Total Imports	Total all Sources
Nov. 13	12	477	27	28	12	8									1	565			565
Nov. 20	49	899	23	33	6	4	1	2							2	1019			1019
Nov. 27	75	354	9	9	3	4		1							2	457			457
Dec. 4	95	801	5	2		2		2	91	1					6	1005			1005
Dec. 11	89	633	1			3		1	134	2					2	865			865
Dec. 18	86	507						1	755	1						1350			1350
Dec. 25	30	233						2	542	1						808			808
Jan. 1	23	251							329	1						604			604
Jan. 8	38	563							305	2						908			908
Jan. 15	22	791							234	2						1049			1049
Jan. 22	26	864							110	14						1014			1014
Jan. 29	39	1206							121	24						1390			1390
Feb. 5	49	1069							63	5	1					1187			1187
Feb. 12	13	910							64	7						994			994
Feb. 19	14	1030							25	3						1072			1072
Feb. 26	37	1295							36	7						1375			1375
Mar. 5	28	839							104	4	2	1				978			978
Mar. 12	27	898							211	1	2	1				1140			1140
Mar. 19	52	558							333	2	1	35	7			988	2	2	990
Mar. 26	24	200							511		4	64	2	1		806			806
Apr. 2	1	162							975	3	5	73	5	1		1225			1225
Total	829	14540	65	72	21	21	1	9	4943	80	15	174	14	2	13	20799	2	2	20801

TABLE XXXIV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF LETTUCE BY STATES FOR SEASON 1927-1928.

Week Ending	DOMESTIC														Total Domestic
	Fla.	Ariz.	Cal.	Idaho	N. J.	Wash.	Va.	N. Mex.	Nev.	Ohio	Texas	Ga.	S. C.	Other States	
Nov. 5	4	3	572	14	34	10								3	640
Nov. 12	21	5	763	12	34	13	1							2	851
Nov. 19	46	8	657	15	32	10	1							3	772
Nov. 26	96	17	411	7	11	4									546
Dec. 3	106	377	528	1		3		5							1020
Dec. 10	83	813	265						1						1162
Dec. 17	81	955	189							3					1228
Dec. 24	30	648	162						1	2					843
Dec. 31	41	485	219							1	1				747
Jan. 7	52	398	604												1054
Jan. 14	57	362	727								2				1148
Jan. 21	44	227	875								5				1151
Jan. 28	34	159	997								10				1200
Feb. 4	20	90	1255								15				1380
Feb. 11	11	65	1076							3	7				1162
Feb. 18	24	64	1097							1	8				1194
Feb. 25	14	100	1243							2	17				1376
Mar. 3	7	92	1220							1	10				1330
Mar. 10	13	91	1018							1	10				1133
Mar. 17	33	82	856							6	6				983
Mar. 24	29	348	557							3	4	1			942
Mar. 31	14	1085	205							4	4	2	1		1315
Apr. 7	10	1200	83							4		3		2	1302
Apr. 14	1	914	248							12			11	5	1191
Total	871	8588	15827	49	111	40	2	5	2	43	99	6	12	15	25670

TABLE XXXV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF LETTUCE BY STATES FOR SEASON 1928-1929.

Week Ending	DOMESTIC															
	Fla.	Ariz.	Cal.	Ohio	Idaho	N. J.	N. Y.	Wash.	Va.	N. Mex.	Nev.	Texas	Ga.	S. C.	Other States	Total Domestic
Nov. 17	6	10	572	2	4	19	1	13	......	......	......	......	......	......	......	627
Nov. 24	30	40	1140	2	1	28	......	10	4	......	......	......	......	......	2	1257
Dec. 1	47	194	655	2	......	6	......	4	2	2	......	......	......	......	......	912
Dec. 8	143	410	292	1	......	......	......	......	......	......	......	......	......	......	......	846
Dec. 15	78	919	206	4	......	......	......	......	......	......	......	......	......	......	......	1207
Dec. 22	78	957	208	2	......	......	......	......	......	......	......	......	......	......	......	1245
Dec. 29	41	493	324	......	......	......	......	......	......	......	......	......	......	......	......	858
Jan. 5	76	900	451	......	......	......	......	......	......	......	1	......	......	......	......	1428
Jan. 12	100	453	530	3	......	......	......	......	......	......	......	......	......	......	......	1086
Jan. 19	102	198	639	2	......	......	......	......	......	......	......	5	......	......	......	946
Jan. 26	64	148	765	2	......	......	......	......	......	......	......	6	......	......	......	985
Feb. 2	41	131	925	1	......	......	......	......	......	......	......	7	......	......	......	1105
Feb. 9	26	31	1145	......	......	......	......	......	......	......	......	5	......	......	......	1207
Feb. 16	27	15	1127	3	......	......	......	......	......	......	......	1	......	......	......	1173
Feb. 23	46	19	1402	......	......	......	......	......	......	......	......	11	......	......	......	1478
Mar. 2	58	9	1397	3	......	......	......	......	......	......	......	20	......	......	......	1487
Mar. 9	62	21	1238	5	......	......	......	......	......	......	......	12	3	7	......	1348
Mar. 16	44	58	916	2	......	......	......	......	......	......	......	5	4	10	......	1039
Mar. 23	29	122	875	4	......	......	......	......	......	......	......	5	2	45	......	1082
Mar. 30	10	203	609	7	......	......	......	......	......	......	......	......	1	116	2	948
Total ..	1108	5331	15416	45	5	53	1	27	6	2	1	77	10	178	4	22264

SUPPLEMENTAL DATA

TABLE XXXVI.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF LETTUCE BY STATES FOR SEASON 1929-1930.

Week Ending	Domestic											Total Domestic
	Fla.	Cal.	Idaho	N. J.	Va.	Wash.	Ariz.	Ohio	Texas	S. C.	Other States	
Nov. 9	1	848	2	22	4	30						907
Nov. 16	23	740		13	2	24					1	803
Nov. 23	14	723		16	1	18						772
Nov. 30	29	702					3					734
Dec. 7	44	676					55	1	1			777
Dec. 14	41	376					259	5				681
Dec. 21	52	348					605	1				1006
Dec. 28	24	310					567	1				902
Jan. 4	23	454					686	1				1164
Jan. 11	21	554					639	1				1215
Jan. 18	59	657					403	2	1			1122
Jan. 25	24	855					195					1074
Feb. 1	14	999					92					1105
Feb. 8	10	1332					37		2			1381
Feb. 15	9	1319					75	1	5			1409
Feb. 22	8	1517					42	1	8	1		1577
Mar. 1	23	1327					41	5	13			1409
Mar. 8	15	1574					27	4	2			1622
Mar. 15	27	1220					145	5				1397
Mar. 22	31	631					423	4	3	3		1095
Mar. 29	20	101					1061	5	19	21		1227
Apr. 5	4	60					1561	2	1	18		1646
Total	516	17323	2	51	7	72	6916	39	55	43	1	25025

TABLE XXXVII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF GREEN PEAS BY STATES AND IMPORTS FOR 1927.

Week Ending	Domestic			Total Domestic	Imports	Total Imports	Total All Sources
	Fla.	Cal.	Texas		Mexico		
SPRING							
Feb. 26	3	14	1	18	88	88	106
Mar. 5	1	39		40	62	62	102
Total	4	53	1	58	150	150	208
FALL							
Nov. 19	1	67		68			68
Nov. 26	2	66		68			68
Dec. 3	2	65	1	68	3	3	71
Dec. 10		48		48	17	17	65
Dec. 17		7		7	18	18	25
Dec. 24	2	8		10	15	15	25
Dec. 31	1			1	26	26	27
Total	8	261	1	270	79	79	349

TABLE XXXVIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF GREEN PEAS BY STATES AND IMPORTS FOR 1928.

Week Ending	Domestic			Total Domestic	Imports	Total Imports	Total All Sources
	Fla.	Cal.	Texas		Mexico		
Mar. 17	1	64	....	65	36	36	101
Mar. 24	1	148	2	151	11	11	162
Total	2	212	2	216	47	47	263

TABLE XXXIX.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF GREEN PEAS BY STATES AND IMPORTS FOR 1929.

Week Ending	Domestic		Total Domestic	Imports	Total Imports	Total All Sources
	Fla.	Cal.		Mexico		
Jan. 26	3	5	8	121	121	129
Feb. 2	11	4	15	76	76	91
Feb. 9	9	3	12	134	134	146
Feb. 16	5	1	6	110	110	116
Feb. 23	2	1	3	103	103	106
Total	30	14	44	544	544	588

SUPPLEMENTAL DATA

TABLE XL.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF GREEN PEAS BY STATES AND IMPORTS FOR 1930.

Week Ending	Domestic		Total Domestic	Imports	Total Imports	Total All Sources
	Fla.	Cal.		Mexico		
Jan. 18	2	....	2	249	249	251
Jan. 25	1	9	10	267	267	277
Feb. 1	....	2	2	215	215	217
Feb. 8	....	3	3	166	166	169
Feb. 15	....	15	15	172	172	187
Feb. 22	....	79	79	149	149	228
Mar. 1	2	68	70	99	99	169
Total	5	176	181	1317	1317	1498

TABLE XLI.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF PEPPERS BY STATES AND IMPORTS FOR SEASON 1924-1925.

	DOMESTIC												IMPORTS			
Week Ending	Fla.	Ga.	La.	Miss.	S. C.	Cal.	N. C.	Va.	Mo.	N. J.	Other States	Total Domestic	Cuba	Bermuda	Total Imports	Total all Sources
Nov. 29	9	17										26				26
Dec. 6	30		2								6	38				38
Dec. 13	13		2									15				15
Dec. 20	21										1	22				22
Dec. 27	5											5				5
Jan. 3	29											29				29
Jan. 10	18											18				18
Jan. 17	22											22	3		3	25
Jan. 24	15											15	11		11	26
Jan. 31	10											10	5		5	15
Feb. 7	4											4	9		9	13
Feb. 14	6											6	14		14	20
Feb. 21	17											17	19		19	36
Feb. 28	9											9	15		15	24
Mar. 7	12											12	27		27	39
Mar. 14	26											26	31		31	57
Mar. 21	25											25	16		16	41
Mar. 28	24											24	53		53	77
Apr. 4	19											19	28		28	47
Apr. 11	20											20	1		1	21
Apr. 18	15											15	14		14	29
Apr. 25	21											21	27		27	48
May 2	41											41	18		18	59
May 9	86											86	6	18	24	110
May 16	51											51	12		12	63
May 23	35											35				35
May 30	73											73				73
June 6	90		6									96				96
June 13	43		36									79				79
June 20	37		61	3	8							109				109
June 27	24		56	2	5	1						88				88
July 4	4		47		2		2					55				55
July 11	2		62	1	3		5	1				74				74
July 18	6		51	2	3		4					66				66
July 25	3		32		1		3		1	9		49				49
Total	265	17	355	8	22	1	14	1	1	9	7	1300	309	18	327	1627

TABLE XLII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF PEPPERS BY STATES AND IMPORTS FOR SEASON 1925-1926.

	DOMESTIC													IMPORTS			
Week Ending	Fla.	Cal.	N. J.	Ohio	Texas	Va.	Ga.	La.	S. C.	Miss.	N. C.	Other States	Total Domestic	Cuba	Mexico	Total Imports	Total all Sources
Oct. 24	1	11	36	1	6								55				55
Oct. 31	9	8	14		5							2	38				38
Nov. 7	27	13	10		2	3							55				55
Nov. 14	31	5	5		3		5					3	52				52
Nov. 21	28	2			3		1						34				34
Nov. 28	12												12				12
Dec. 5	29												29				29
Dec. 12	37												37	1		1	38
Dec. 19	33												33	3	3	6	39
Dec. 26	16												16	4	10	14	30
Jan. 2	22												22	11	10	21	43
Jan. 9	15												15	20	6	26	41
Jan. 16	9												9	28	21	49	58
Jan. 23	8												8	33	7	40	48
Jan. 30	5												5	26	2	28	33
Feb. 6	3												3	54	3	57	60
Feb. 13	1												1	28	11	39	40
Feb. 20	3												3	14	6	20	23
Feb. 27	1												1	47	4	51	52
Mar. 6	1												1	50	6	56	57
Mar. 13	1												1	45	6	51	52
Mar. 20	3												3	58	9	67	70
Mar. 27	1												1	57	3	60	61
Apr. 3	3												3	60	8	68	71
Apr. 10	1												1	54	12	66	67
Apr. 17	13												13	61	21	82	95
Apr. 24	24												24	30	19	49	73
May 1	13												13	11	3	14	27
May 8	17												17	9	3	12	29
May 15	38												38	16	1	17	55
May 22	23												23	5		5	28
May 29	26												26	13		13	39
June 5	20												20	17		17	37
June 12	34							5					39	12		12	51
June 19	60							20					80	5		5	85
June 26	65						3	31	2				101	3		3	104
July 3	33						4	68	3	3			111	1		1	112
July 10	19						1	89	4	4			117				117
July 17	7						3	88	2	2	2		104				104
July 24	2						1	56		2	1		62				62
Total	694	39	65	1	19	3	18	357	11	11	3	5	1226	776	174	950	2176

TABLE XLIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF PEPPERS BY STATES AND IMPORTS FOR SEASON 1926-1927.

Week Ending	DOMESTIC												IMPORTS				
	Fla.	Cal.	N. J.	Texas	Va.	Ga.	La.	Miss.	S. C.	N. C.	Other States	Total Domestic	Cuba	Mexico	Porto Rico	Total Imports	Total all Sources
Nov. 6	5	18	34	4	1							62					62
Nov. 13	16	15	17	11		4						63					63
Nov. 20	24	5	8	6							1	44					44
Nov. 27	16											16					16
Dec. 4	22											22					22
Dec. 11	23											23					23
Dec. 18	41											41	3	1		4	45
Dec. 25	26											26	9	4		13	39
Jan. 1	32											32	14	5		19	51
Jan. 8	31											31	23	27		50	81
Jan. 15	12											12	19	18		37	49
Jan. 22													23	18		41	41
Jan. 29													20	9		29	29
Feb. 5	1											1	34	10		44	45
Feb. 12	9											9	44	16	1	61	70
Feb. 19	12											12	53	43	1	97	109
Feb. 26	8											8	47	85	1	133	141
Mar. 5	30											30	51	32	2	85	115
Mar. 12	30											30	56	26	1	83	113
Mar. 19	33											33	38	14	1	53	86
Mar. 26	64											64	37	10	2	49	113
Apr. 2	85											85	19	13		32	117
Apr. 9	106											106	30	14	2	46	152
Apr. 16	60											60	26	13	1	40	100
Apr. 23	52											52	8	15	1	24	76
Apr. 30	38											38	3	4	1	8	46
May 7	47											47	5	11		16	63
May 14	51											51	4	2	2	8	59
May 21	74											74	3	2	2	7	81
May 28	97											97	2		1	3	100
June 4	97						9					106	3		2	5	111
June 11	57					3	24	2				86	3			3	89
June 18	36						55	3				94	1			1	95
June 25	30			3		9	106	2				150					150
July 2	9			2		3	67	3	2			86					86
July 9				2		5	50			3		60					60
July 16	4					4	32		2	15		57					57
July 23	2		1			10	15			8		36					36
Total	1280	38	60	28	1	38	358	10	4	26	1	1844	578	392	21	991	2835

TABLE XLIV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF PEPPERS BY STATES AND IMPORTS FOR SEASON 1927-1928.

Week Ending	DOMESTIC													IMPORTS			
	Fla.	Cal.	N. J.	Ohio	Texas	Va.	Ga.	La.	Miss.	N. C.	S. C.	Other States	Total Domestic	Mexico	Cuba	Total Imports	Total all Sources
Oct. 22	3	14	75	1	3	1						2	99				99
Oct. 29	23	3	59		4	2							91				91
Nov. 5	34	3	34		5	1							77				77
Nov. 12	46	2	14		2		4					2	70				70
Nov. 19	85	5			3							8	101				101
Nov. 26	58	2			2							1	63				63
Dec. 3	100	4			12							1	117				117
Dec. 10	68												68	1		1	69
Dec. 17	42												42	3		3	45
Dec. 24	26												26				26
Dec. 31	27												27	2	6	8	35
Jan. 7	43												43	15		15	58
Jan. 14	30												30	19	22	41	71
Jan. 21	23												23	17	23	40	63
Jan. 28	28												28	22	11	33	61
Feb. 4	20												20	15	32	47	67
Feb. 11	23												23	26	26	52	75
Feb. 18	48												48	58	32	90	138
Feb. 25	29												29	64	28	92	121
Mar. 3	35												35	46	22	68	103
Mar. 10	50												50	28	19	47	97
Mar. 17	45												45	17	22	39	84
Mar. 24	60												60	13	18	31	91
Mar. 31	55												55	11	12	23	78
Apr. 7	127												127	11	8	19	146
Apr. 14	71												71	6	6	12	83
Apr. 21	92												92	9	6	15	107
Apr. 28	102												102	10	7	17	119
May 5	82												82	10	5	15	97
May 12	71												71	24	2	26	97
May 19	69												69	12	1	13	82
May 26	66												66	3		3	69
June 2	97												97				97
June 9	110												110				110
June 16	42							45					87				87
June 23	63				1			49					113				113
June 30	39				1		1	89	1	4			135				135
July 7	9				4		4	75	4	22			118				118
July 14	2		1	1	2		4	58	3	19	2		92				92
July 21	4		2				2	13		7	7		35				35
July 28	2		18				4	8		6	2		40				40
Total	2049	33	203	2	39	4	19	337	8	58	11	14	2777	442	308	750	3527

TABLE XLV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF PEPPERS BY STATES AND IMPORTS FOR SEASON 1928-1929.

Week Ending	DOMESTIC										IMPORTS			
	Fla.	La.	Ga.	Miss.	N. C.	S. C.	Texas	N. J.	Other States	Total Domestic	Mexico	Cuba	Total Imports	Total all Sources
Nov. 24	4									4	1		1	5
Dec. 1	4									4				4
Dec. 8	2									2				2
Dec. 15	7									7	8	3	11	18
Dec. 22	5									5	10	3	13	18
Dec. 29	9									9	11	8	19	28
Jan. 5	13									13	15	10	25	38
Jan. 12	6									6	27	11	38	44
Jan. 19	7									7	21	14	35	42
Jan. 26	25									25	27	30	57	82
Feb. 2	29									29	13	14	27	56
Feb. 9	32									32	22	28	50	82
Feb. 16	29									29	25	18	43	72
Feb. 23	78									78	20	25	45	123
Mar. 2	85									85	17	33	50	135
Mar. 9	83									83	7	26	33	116
Mar. 16	107									107		18	18	125
Mar. 23	92									92	17	8	25	117
Mar. 30	98									98	17	12	29	127
Apr. 6	77									77	3	7	10	87
Apr. 13	103									103		3	3	106
Apr. 20	87									87	3	2	5	92
Apr. 27	103									103	1	1	2	105
May 4	123									123		1	1	124
May 11	93									93	4	1	5	98
May 18	102									102	9		9	111
May 25	148	3								151	5		5	156
June 1	81	10	1							92	5		5	97
June 8	61	18	2							81	1		1	82
June 15	72	46	2							120				120
June 22	21	58	5							84				84
June 29	17	86	7	1	8	2				121				121
July 6	4	43	7		11	2				67				67
July 13	3	25	5	1	16	3	1			54				54
July 20		25		1	36	4			2	68				68
July 27	1	11			25	3		7	1	48				48
Total	1811	325	29	3	96	14	1	7	3	2289	289	276	565	2854

SUPPLEMENTAL DATA

TABLE XLVI.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF PEPPERS BY STATES AND IMPORTS FOR SEASON 1929-1930.

Week Ending	DOMESTIC											IMPORTS				
	Fla.	Cal.	Ga.	Va.	La.	Miss.	N. C.	S. C.	N. J.	Other States	Total Domestic	Cuba	Mexico	Porto Rico	Total Imports	Total all Sources
Nov. 9	2	18	1	5						1	27					27
Nov. 16	6	6	5		1					3	21					21
Nov. 23	10		27		1	1				5	44					44
Nov. 30	12		15								27	6	2		8	35
Dec. 7	13				1					2	16	11			11	27
Dec. 14	28				3						31	12			12	43
Dec. 21	41										41	15	1		16	57
Dec. 28	11										11	13	5		18	29
Jan. 4	15										15	11	7	1	19	34
Jan. 11	15										15	15	8	1	24	39
Jan. 18	11										11	17	7		24	35
Jan. 25	18										18	15	6		21	39
Feb. 1	19										19	14	18		32	51
Feb. 8	13										13	22	5		27	40
Feb. 15	15										15	14	9		23	38
Feb. 22	11										11	9	10		19	30
Mar. 1	34										34	7	15		22	56
Mar. 8	41										41	9	10		19	60
Mar. 15	48										48	7	11		18	66
Mar. 22	54										54	7	9		16	70
Mar. 29	70										70	7	14		21	91
Apr. 5	95										95	6	16		22	117
Apr. 12	95										95	4	19		23	118
Apr. 19	67										67	2	12		14	81
Apr. 26	59										59	1	16		17	76
May 3	78										78		9		9	87
May 10	104										104		8		8	112
May 17	94										94		8		8	102
May 24	87										87		6		6	93
May 31	124				4						128		3		3	131
June 7	149				13						162		2		2	164
June 14	74		1		14						89					89
June 21	67		4		68		4	2			145					145
June 28	26	2	11		44		17	4			104					104
July 5	3	1	4		11		12	6			37					37
July 12	4	3	5		7	1	54	6			80					80
July 19	2		5		7	1	49	10	6		80					80
Total	1615	30	78	5	174	3	136	28	6	11	2086	224	236	2	462	2548

TABLE LIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF STRAWBERRIES BY STATES FOR 1925.

Week Ending	DOMESTIC								Total Domestic
	Fla.	La.	Texas	Ala.	Miss.	N. C.	Ark.	S. C.	
Jan. 3	5								5
Jan. 10	32								32
Jan. 17	52								52
Jan. 24	81								81
Jan. 31	51								51
Feb. 7	50								50
Feb. 14	64								64
Feb. 21	68								68
Feb. 28	63								63
Mar. 7	35								35
Mar. 14	24	7							31
Mar. 21	46	53	1						100
Mar. 28	28	76	8	2					114
Apr. 4	21	127	10	12	2				172
Apr. 11	10	163	3	100	11	4			291
Apr. 18	1	133		127	17	136	12	3	429
Total	631	559	22	241	30	140	12	3	1638

TABLE LIV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF STRAWBERRIES BY STATES FOR 1926.

Week Ending	DOMESTIC				Total Domestic
	Fla.	Cal.	La.	Texas	
Jan. 30	2				2
Feb. 6	3				3
Feb. 13	5				5
Feb. 20	13				13
Feb. 27	26				26
Mar. 6	43				43
Mar. 13	54				54
Mar. 20	39	1			40
Mar. 27	81	3	1	2	87
Apr. 3	27	4	26	2	59
Apr. 10	6	2	142	3	153
Total	299	10	169	7	485

TABLE LV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF STRAWBERRIES BY STATES FOR 1927.

Week Ending	DOMESTIC											
	Fla.	La.	Texas	Ala.	Cal.	N. C.	Ark.	Miss.	S. C.	Ga.	Tenn.	Total Domestic
Jan. 8	1											1
Jan. 15	5											5
Jan. 22	2											2
Jan. 29	11											11
Feb. 5	7											7
Feb. 12	4											4
Feb. 19	58											58
Feb. 26	108	14										122
Mar. 5	89	44	7									140
Mar. 12	145	133	17	3								298
Mar. 19	104	125	19	28								276
Mar. 26	26	92	14	28	1							161
Apr. 2	16	108	22	19	2							167
Apr. 9	17	251	23	108	2	18						419
Apr. 16	14	266	10	185	1	177	2	11	4			670
Apr. 23	4	347	8	183	5	736	18	20	10	4	9	1344
Total	611	1380	120	554	11	931	20	31	14	4	9	3685

TABLE LVI.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF STRAWBERRIES BY STATES FOR 1928.

Week Ending	DOMESTIC																					Total Domestic
	Fla.	Texas	La.	Ala.	Ark.	Cal.	Miss.	N. C.	S. C.	Ga.	Okla.	Tenn.	Va.	Ill.	Mo.	Ky.	Md.	Ore.	Wash.	Del.	Iowa	Kan.	Other States	
Jan. 21	7																						7
Jan. 28	4																						4
Feb. 4	3																						3
Feb. 11	7																						7
Feb. 18	17																						17
Feb. 25	17																						17
Mar. 3	35																						35
Mar. 10	115																						115
Mar. 17	64	5																					69
Mar. 24	35	18	2																				55
Mar. 31	48	25	87																				160
Apr. 7	58	23	316	46																			443
Apr. 14	68	7	298	108																			481
Apr. 21	30	22	458	172	5	11																	698
Apr. 28	18	21	524	112	21	23	10	27	12														768
May 5		17	573	175	126	35	23	448	28	2	2	9										1	1439
May 12	2	8	388	139	239	40	34	685	13	8	1	158	37										1752
May 19	2	6	206	119	713	23	34	801	11	12	17	643	193	7	5							5	2797
May 26	3			62	535	17	8	167			16	453	537	81	466	37	96	2	14				14	2508
June 2	2			65	316	2	2	9			9	485	208	98	1239	484	391	26	5	115	2	2		3460
Total	535	152	2852	998	1955	151	111	2137	64	22	45	1748	975	186	1710	521	487	28	19	115	2	2	20	14835

TABLE LVII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF STRAWBERRIES BY STATES FOR 1929.

Week Ending	DOMESTIC																			Total Domestic
	Fla.	La.	Texas	Ala.	Miss.	N. C.	S. C.	Ark.	Cal.	Ga.	Tenn.	Va.	Okla.	Ill.	Ky.	Md.	Del.	Mo.	Other States	
Jan. 5	3																			3
Jan. 12	4																			4
Jan. 19	11																			11
Jan. 26	85																			85
Feb. 2	98																			98
Feb. 9	110																			110
Feb. 16	117																			117
Feb. 23	216																			216
Mar. 2	312																			312
Mar. 9	215																			215
Mar. 16	203																			203
Mar. 23	121	2																		123
Mar. 30	61	121	5																	187
Apr. 6	37	516	61	132																746
Apr. 13	15	577	90	249	13	6	2													952
Apr. 20	6	373	19	288	23	260	11													980
Apr. 27	13	627	44	223	26	824	13	26	3	2	7	6								1814
May 4	3	507	24	200	32	458	4	236	10	7	264	148	6							1899
May 11	1	149	9	119	17	95		672	22	6	704	344	25	8	6	10				2187
May 18	1			89	2	23		959	56		897	297	31	84	277	124	8	23	5	2876
Total	1632	2872	252	1300	113	1666	30	1893	91	15	1872	795	62	92	283	134	8	23	5	13138

SUPPLEMENTAL DATA

TABLE LVIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF STRAWBERRIES BY STATES FOR 1929-1930.

Week Ending	DOMESTIC																				Total Domestic
	Fla.	La.	Texas	Ala.	Ariz.	Cal.	Ark.	Miss.	N. C.	Ga.	Okla.	Tenn.	Ill.	Ky.	Mo.	S. C.	Va.	Md.	Wash.	Other States	
Dec. 14	20																				20
Dec. 21	49																				49
Dec. 28	21																				21
Jan. 4	61																				61
Jan. 11	89																				89
Jan. 18	118																				118
Jan. 25	59																				59
Feb. 1	51																				51
Feb. 8	81																				81
Feb. 15	83																				83
Feb. 22	92																				92
Mar. 1	220																				220
Mar. 8	175																				175
Mar. 15	160	3																			163
Mar. 22	146	16																			162
Mar. 29	66	33	1																		100
Apr. 5	39	90	11	21																	161
Apr. 12	45	270	23	65	1	6															410
Apr. 19	62	399	34	264	2	25	2	11	2												801
Apr. 26	18	460	20	174	3	31	26	8	7												747
May 3	20	620	12	158		48	237	31	411	3	13	235									1788
May 10	15	370	4	44		31	242	16	355	4	17	474	30	11	54	2	12				1681
May 17	19	116		33		24	128	4	132		6	308	37	129	247	4	175	18	1	5	1386
Total	1709	2377	105	759	6	165	635	70	907	7	36	1017	67	140	301	6	187	18	1	5	8518

TABLE LIX.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF TOMATOES BY STATES AND IMPORTS FOR SEASON 1924-1925.

Week Ending	DOMESTIC																		IMPORTS				
	Fla.	Cal.	Texas	Ohio	Miss.	Ga.	La.	S. C.	Ark.	Tenn.	Okla.	Md.	Va.	Ill.	N. J.	W. Va.	Other States	Total Domestic	Bahama Islands	Mexico	Cuba	Total Imports	Total all Sources
Nov. 22	4	69	6	4														83					83
Nov. 29	4	23	9	2														38	6			6	44
Dec. 6	2	15	3	3														23	3	1		4	27
Dec. 13	7	13	2															22	4	1	2	7	29
Dec. 20	7																	7	9	8	10	27	34
Dec. 27	12																	12	8	8	6	22	34
Jan. 3	8																	8	19	31	3	53	61
Jan. 10	8																	8		27		27	35
Jan. 17	10																	10	26	50	4	80	90
Jan. 24	45																	45		74	14	88	133
Jan. 31	137																	137	2	58	8	68	205
Feb. 7	152		3															155	1	100	7	108	263
Feb. 14	163		3															166	1	93	4	98	264
Feb. 21	277		2															279		61	4	65	344
Feb. 28	249		2															251		71	3	74	325
Mar. 7	198		1															199		42	4	46	245
Mar. 14	246																	246		68	4	72	318
Mar. 21	213																	213		89	2	91	304
Mar. 28	203																	203		105	3	108	311
Apr. 4	304																	304		238	1	239	543
Apr. 11	231																	231		248		248	479
Apr. 18	304																	304		234	5	239	543
Apr. 25	401	1	1															403		311		311	714
May 2	600	1																601		277		277	878
May 9	686	4	8															698		171		171	869
May 16	804	10	59															873		114		114	987
May 23	574	18	147		105													844		92		92	936
May 30	299	19	301		681	5	2	11										1318		33		33	1351
June 6	368	23	622		839	2	1	30										1885		15		15	1900
June 13	277	29	686	4	642	16	3	74	2	2								1735		4		4	1739
June 20	149	26	291	3	590	25		124	8	76	8						3	1303		6		6	1309
June 27	25	19	80	4	220	20		136	16	495	16							1031					1031
July 4	8	20	10	5	39	5		92	16	423	16	1	13					648					648
July 11	1	19	22	29	15	3		62	13	235	7	25	78	21	2	1	3	536					536
Total	6976	309	2258	54	3131	76	6	529	55	1231	47	26	91	21	2	1	6	14819	79	2630	84	2793	17612

TABLE LX.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF TOMATOES BY STATES AND IMPORTS FOR SEASON 1925-1926.

Week Ending	DOMESTIC																					IMPORTS				
	Fla.	Cal.	Texas	Ga.	Miss.	Ohio	S. C.	Ill.	La.	Ark.	Okla.	Tenn.	Wash.	Va.	Md.	N. J.	Ky.	Mo.	W. Va.	Other States	Total Domestic	Cuba	Mexico	Bahama Islands	Total Imports	Total all Sources
Nov. 28	2	24	10																		36	11	1		12	48
Dec. 5	10	23	18																		51	20	10	8	38	89
Dec. 12	22	26	6																		54	39	22		61	115
Dec. 19	17	6	7																		30	47	20	27	94	124
Dec. 26	1	5	5																		11	26	58		84	95
Jan. 2	3																				3	42	62	32	136	139
Jan. 9	2																				2	48	36	24	108	110
Jan. 16																						20	132	23	175	175
Jan. 23																						16	118	35	169	169
Jan. 30																						18	125	27	170	170
Feb. 6																						24	113		137	137
Feb. 13																						16	118	52	186	186
Feb. 20	10																				10	15	144		159	169
Feb. 27	23																				23	20	186	18	224	247
Mar. 6	33																				33	18	193	12	223	256
Mar. 13	33																				33	16	145		161	194
Mar. 20	44																				44	18	199		217	261
Mar. 27	124																				124	35	197	7	239	363
Apr. 3	189																				189	21	208	4	233	422
Apr. 10	231																				231	23	149		172	403
Apr. 17	251																				251	22	198	1	221	472
Apr. 24	288	2																			290	17	129		146	436
May 1	342	11																			353	3	105		108	461
May 8	210	25	41																		276	3	84		87	363
May 15	318	24	122																		464		71		71	535
May 22	538	55	202																		795		65		65	860
May 29	702	61	208																		971		65		65	1036
June 5	484	48	186	4	1	1	3														727		26		26	753
June 12	171	28	327	8	513		20	1	1												1069					1069
June 19	107	28	633	24	1464	4	78		2	2	2	1	1								2346					2346
June 26	62	22	619	35	1017	5	141		6	28	23	97									2055					2055
July 3	16	31	198	53	401	4	130		3	62	42	638		6							1584					1584
July 10	4	16	61	20	64	8	49	5	2	44	25	590		80	23	29					1020					1020
July 17	2	19	23	1	10	27	12	31		33	11	494		145	37	73	2	4	2	2	928					928
Total	4239	454	2666	145	3470	49	433	37	14	169	103	1820	1	231	60	102	2	4	2	2	14003	538	2979	270	3787	17790

TABLE LXI.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF TOMATOES BY STATES AND IMPORTS FOR SEASON 1927.

Week Ending	DOMESTIC													Total Domestic	IMPORTS				Total Imports	Total all Sources
	Fla.	Texas	Cal.	Miss.	Ga.	Ohio	S. C.	La.	Ark.	Okla.	Wash.	Tenn.	Va.		Bahama Islands	Cuba	Mexico	Porto Rico		
Jan. 1	1	14												15	2	6	79		87	102
Jan. 8	5													5	31	16	113		160	165
Jan. 15	6													6	47	24	72		143	149
Jan. 22	10													10	43	32	113		188	198
Jan. 29	30													30	41	17	102		160	190
Feb. 5	69													69	41	22	106		169	238
Feb. 12	113													113	31	26	230	1	288	401
Feb. 19	139													139	23	52	206		281	420
Feb. 26	118													118	16	52	410	2	480	598
Mar. 5	199													199	8	72	359	2	441	640
Mar. 12	362													362	3	68	303	2	376	738
Mar. 19	527													527	4	62	243	2	311	838
Mar. 26	571													571	2	47	277		326	897
Apr. 2	739													739	2	45	357		404	1143
Apr. 9	690													690		33	386		419	1109
Apr. 16	571													571		26	370		396	967
Apr. 23	846	2												848		8	279		287	1135
Apr. 30	1147	8	1											1156		7	233		240	1396
May 7	1211	48	7											1266		4	118		122	1388
May 14	1027	141	8	1										1177			60		60	1237
May 21	694	233	36	178	2									1143			57		57	1200
May 28	423	418	23	1116	2	2	3							1987			48		48	2035
June 4	109	564	29	1390	3	2	11	1						2109						2109
June 11	58	807	47	1103	4	2	21	1						2043						2043
June 18	19	637	44	818	9	4	46	1	7					1585						1585
June 25	3	204	29	203	9	7	56	1	37	2	1	204		756						756
July 2	2	65	22	16	4	9	36	1	37	6		608	7	813						813
Total	9689	3141	246	4825	33	26	173	5	81	8	1	812	7	1 9047	294	619	4521	9	5443	24490

TABLE LXII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF TOMATOES BY STATES AND IMPORTS FOR SEASON 1927-1928.

Week Ending	DOMESTIC											IMPORTS				
	Fla.	Cal.	Texas	Ohio	Ga.	Miss.	S. C.	Ark.	Okla.	Other States	Total Domestic	Bahama Islands	Mexico	Cuba	Total Imports	Total all Sources
Nov. 26	11	32	18	3						2	66	16	14		30	96
Dec. 3	19	7	30	6							62	4	54	2	60	122
Dec. 10	41	7	19	1							68	42	94		136	204
Dec. 17	72		13								85	13	72		85	170
Dec. 24	50										50	92	12	1	105	155
Dec. 31	75										75	25	36	96	157	232
Jan. 7	59										59	51	159	6	216	275
Jan. 14	111										111	20	107	63	190	301
Jan. 21	138										138	26	70	95	191	329
Jan. 28	152										152	33	61	66	160	312
Feb. 4	76										76	21	57	57	135	211
Feb. 11	102										102	10	65	57	132	234
Feb. 18	86										86	8	77	72	157	243
Feb. 25	38										38	4	84	61	149	187
Mar. 3	42										42	1	120	53	174	216
Mar. 10	63										63		224	59	283	346
Mar. 17	104										104		220	47	267	371
Mar. 24	146										146		309	31	340	486
Mar. 31	180										180		404	17	421	601
Apr. 7	325										325		411	12	423	748
Apr. 14	357										357		350	5	355	712
Apr. 21	591										591		379	2	381	972
Apr. 28	743	3	1								747		279		279	1026
May 5	809	17									826		168		168	994
May 12	958	16	3								977		117		117	1094
May 19	1199	38	96								1333		60		60	1393
May 26	752	80	439	2							1273		43		43	1316
June 2	521	96	498	2	1						1118		15		15	1133
June 9	457	68	462	2	5	263	1				1258					1258
June 16	129	43	689	9	6	962	3	8			1849					1849
June 23	24	30	988	15	19	1248	33	42	7		2406					2406
Total	8430	437	3256	40	31	2473	37	50	7	2	14763	366	4061	802	5229	19992

TABLE LXIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF TOMATOES BY STATES AND IMPORTS FOR SEASON 1928-1929.

Week Ending	DOMESTIC											IMPORTS					
	Fla.	Cal.	Texas	Ohio	Ga.	Miss.	S. C.	Ark.	Wash.	Other States	Total Domestic	Cuba	Mexico	Bahama Islands	Bermuda	Total Imports	Total all Sources
Nov. 10	13	327	1	3						2	346						346
Nov. 17	29	145	12	4						1	191	1				1	192
Nov. 24	25	155	25	3							208	3	18	5		26	234
Dec. 1	49	49	18	2							118	27	34	5		66	184
Dec. 8	75	8	12	4						3	102	64	90	18		172	274
Dec. 15	114	5	14							2	135	105	135	33		273	408
Dec. 22	113		12							2	127	179	125	40		344	471
Dec. 29	55		4								59	71	86	45		202	261
Jan. 5	92										92	138	97	81		316	408
Jan. 12	91										91	100	150	57		307	398
Jan. 19	119										119	82	126	47		255	374
Jan. 26	167										167	74	154	34		262	429
Feb. 2	201										201	32	142	12		186	387
Feb. 9	243										243	76	275	15		366	609
Feb. 16	286										286	71	275	7		353	639
Feb. 23	360										360	56	268	2		326	686
Mar. 2	327										327	52	246	1		299	626
Mar. 9	309										309	36	80			116	425
Mar. 16	413										413	32	74			106	519
Mar. 23	356										356	40	284			324	680
Mar. 30	382										382	22	369			391	773
Apr. 6	235										235	9	287			296	531
Apr. 13	315										315	9	263			272	587
Apr. 20	558										558	3	162			165	723
Apr. 27	731	1	11								743	2	120			122	865
May 4	783		62								845		144			144	989
May 11	653	2	251								906		232			232	1138
May 18	422	2	420								844		243		1	244	1088
May 25	214	9	561	2	1	61					848		115			115	963
June 1	119	26	339	5	2	891	3				1385		10			10	1395
June 8	67	34	902	2	11	1273	42				2331						2331
June 15	22	37	1059	3	7	912	87	4	1		2132						2132
Total	7938	800	3703	28	21	3137	132	4	1	10	15774	1284	4604	402	1	6291	22065

SUPPLEMENTAL DATA

TABLE LXIV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF TOMATOES BY STATES AND IMPORTS FOR SEASON 1929-1930.

Week Ending	DOMESTIC																	IMPORTS					
	Fla.	Cal.	Ohio	Texas	Miss.	S. C.	Ala.	Ga.	Ark.	La.	Wash.	N. C.	Okla.	Tenn.	Va.	Other States	Total Domestic	Cuba	Mexico	Porto Rico	Bahama Islands	Total Imports	Total all Sources
Nov. 23	1	104	3	82													190	9	1			10	200
Nov. 30	2	41	5	28												1	77	25	4	1		30	107
Dec. 7	3	32	8	39													82	52	16		1	69	151
Dec. 14	11	13	8	11													43	136	21		2	159	202
Dec. 21	20	11	2	1													34	121	38	1	2	162	196
Dec. 28	11																11	109	38	1	7	155	166
Jan. 4	13																13	77	36	1	12	126	139
Jan. 11	23																23	85	65	1	4	155	178
Jan. 18	33																33	41	86	1	31	159	192
Jan. 25	55																55	51	92	1	27	171	226
Feb. 1	59																59	40	177		28	245	304
Feb. 8	95																95	31	152		24	207	302
Feb. 15	150																150	26	236		19	281	431
Feb. 22	215																215	24	365		9	398	613
Mar. 1	195																195	23	374			397	592
Mar. 8	193																193	15	482			497	690
Mar. 15	204																204	13	541			554	758
Mar. 22	356																356	13	434			447	803
Mar. 29	469																469	12	728			740	1209
Apr. 5	266																266	11	656			667	933
Apr. 12	360																360	6	404			410	770
Apr. 19	350																350	4	265			269	619
Apr. 26	406	2		1													409	1	214			215	624
May 3	537	4		22													563	1	222			223	786
May 10	514	16		210													740		119			119	859
May 17	678	24		1051													1753		48			48	1801
May 24	607	26	2	680	1	2											1318		16			16	1334
May 31	420	32	3	871	152	5	1	1									1485						1485
June 7	155	23	3	1248	977	18	1		3	1							2429						2429
June 14	62	27	11	1151	979	40	4	6	5	2	1						2288						2288
June 21	5	35	23	854	869	72		7	43			1	9	5		3	1926						1926
June 28	3	15	6	533	392	126		8	55			3	10	570	6		1727						1727
Total	6471	405	74	6782	3370	263	6	22	106	3	1	4	19	575	6	4	18111	926	5830	7	166	6929	25040

TABLE LXV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF WATERMELONS BY STATES AND IMPORTS FOR 1925.

Week Ending	DOMESTIC																	Imports		
	Fla.	Texas	Ariz.	Cal.	Ga.	Ala.	La.	Miss.	S. C.	Colo.	Ark.	N. C.	Mo.	Nev.	Okla.	Idaho	Ore.	Total Domestic	Mexico	Total Imports	Total all Sources
May 9	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	2	4
May 16	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	25	2	2	27
May 23	56	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	62	10	10	72
May 30	285	53	8	45	...	...	...	...	...	...	...	...	...	...	...	...	...	391	6	6	397
June 6	697	89	20	181	...	...	...	...	...	...	...	...	...	...	...	...	...	987	4	4	991
June 13	1025	136	26	378	5	...	...	...	...	...	...	...	...	...	...	...	...	1570	...	...	1570
June 20	1049	162	37	273	447	38	8	3	6	...	...	...	...	...	...	...	...	2023	...	...	2023
June 27	1954	134	17	483	2191	244	15	37	21	...	...	...	...	...	...	...	...	5096	...	...	5096
July 4	895	155	27	446	1897	195	5	31	103	1	...	...	...	...	...	...	...	3755	...	...	3755
July 11	514	270	5	367	1581	332	...	18	500	...	1	...	...	...	...	...	...	3588	...	...	3588
July 18	246	499	11	440	1996	230	...	30	1300	...	33	9	...	...	...	...	...	4794	...	...	4794
July 25	40	423	4	294	1498	154	1	21	654	...	59	91	21	1	3	...	...	3264	...	...	3264
Aug. 1	8	316	2	205	1156	151	2	4	477	...	79	186	89	1	9	1	1	2687	...	...	2687
Total	6796	2243	157	3112	10771	1344	31	144	3061	1	172	286	110	2	12	1	1	28244	24	24	28268

TABLE LXVI.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF WATERMELONS BY STATES FOR 1926.

Week Ending	DOMESTIC																							
	Fla.	Ariz.	Cal.	Texas	Ga.	Ala.	N. C.	S. C.	Idaho	Ky.	La.	Miss.	Nev.	Ark.	Mo.	Okla.	Ore.	Wash.	Ill.	Ind.	Md.	Utah	Va.	Other States	Total Domestic
May 29	16	10	190																						216
June 5	117	11	385	7																					520
June 12	264	29	686	171																					1150
June 19	757	25	618	630	2																				2032
June 26	1986	30	781	567	814	11																			4189
July 3	1763	24	911	722	1985	54	1	13																	5473
July 10	1702	12	570	834	3408	260		322	1	1	4	20	2												7136
July 17	1204	8	658	822	3512	451	1	942			8	36	8	1											7681
July 24	158	9	640	679	3106	335	8	1266	1			31	6	21	26										6286
July 31	60	1	232	892	2546	220	70	1210	2		3	26	3	95	124	15	5	10							5514
Aug. 7	13		120	373	1611	103	223	615			4	16		91	229	72	7	29							3506
Aug. 14	4		107	126	1063	46	260	289	13			11		85	480	50	5	36	4	4	7	1	58	3	2652
Total	8044	159	5898	5823	18077	1480	563	4657	17	1	19	140	19	293	859	137	17	75	4	4	7	1	58	3	46355

TABLE LXVII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF WATERMELONS BY STATES AND IMPORTS FOR 1927.

Week Ending	DOMESTIC																					Total Domestic	Imports	Total Imports	Total all Sources
	Fla.	Cal.	Texas	Ariz.	Ala.	Ga.	Miss.	S. C.	La.	Ark.	Nev.	N. C.	Mo.	Okla.	Ill.	Wash.	Idaho	Va.	Md.	Ore.	Other States		Mexico		
Apr. 30	3																					3			3
May 7	22																					22			22
May 14	109																					109	1	1	110
May 21	232	4	4																			240	7	7	247
May 28	746	26	85																			857	3	3	860
June 4	1035	57	292	4																		1388	1	1	1389
June 11	1079	260	311	7	2	94																1753			1753
June 18	2174	341	790	13	38	1113	2	1														4472			4472
June 25	1354	547	994	25	144	1776	17	14														4871			4871
July 2	772	616	887	19	199	1841	41	95	11													4481			4481
July 9	285	597	580	17	228	1754	44	284	21													3810			3810
July 16	208	512	439	21	150	2644	22	903	16													4915			4915
July 23	120	575	594	8	180	3439	10	1201	7	27	1	1										6163			6163
July 30	32	591	491	15	140	1878	16	791	3	78	1	83	1	5								4125			4125
Aug. 6	18	351	319	4	76	1071	5	303		111	3	535	6	72	1	1						2876			2876
Aug. 13	10	234	103	1	51	346	7	69		71	4	280	28	115		18	1	8			5	1351			1351
Aug. 20	2	109	43		39	224	3	37		43		130	58	87		47	3	66	6	4	5	906			906
Aug. 27	2	93	28		23	171	2	3		12		10	69	47	2	53	8	78	29	2	8	640			640
Total	8203	4913	5960	134	1270	16351	169	3701	58	342	9	1039	162	326	3	119	12	152	35	6	18	42982	12	12	42994

TABLE LXVIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF WATERMELONS BY STATES AND IMPORTS FOR 1928.

Week Ending	DOMESTIC																			Imports		
	Fla.	Cal.	Ariz.	Texas	Ala.	Ga.	Ark.	S. C.	Miss.	N. C.	La.	Nev.	Idaho	Mo.	Okla.	Ore.	Va.	Wash.	Colo.	Total Domestic	Mexico	Total Imports	Total all Sources
May 5	6																			6			6
May 12	9																			9	3	3	12
May 19	27	2																		29	13	13	42
May 26	83	63	1																	147	6	6	153
June 2	271	228	4	2																505	1	1	506
June 9	1418	376	3	21	1															1819			1819
June 16	1111	454	12	128																1705			1705
June 23	1153	650	21	1046																2870			2870
June 30	1690	752	20	931	1	78														3472			3472
July 7	1343	489	9	635	38	2334	1	42												4891			4891
July 14	847	722	4	856	119	3492		355	13	11										6419			6419
July 21	364	786	6	835	186	3147		1217	46	5	2	4								6598			6598
July 28	64	432	4	456	163	2285	16	1080	49	76	15	2								4642			4642
Aug. 4	17	241	3	545	81	2064	65	722	24	236	1	4	7	1	4	1	1	11		4028			4028
Aug. 11	5	144		437	24	1297	97	349	26	517		2	9	58	82	4	38	36	1	3126			3126
Total	8408	5339	87	5892	613	14697	179	3765	158	845	18	12	16	59	86	5	39	47	1	40266	23	23	40289

TABLE LXIX.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF WATERMELONS BY STATES AND IMPORTS FOR 1929.

Week Ending	DOMESTIC															Imports		
	Fla.	Texas	Cal.	Ariz.	Ga.	Ala.	Miss.	S. C.	La.	Ark.	N. C.	Okla.	Ind.	Mo.	Total Domestic	Mexico	Total Imports	Total all Sources
Apr. 20	5														5			5
Apr. 27	15														15			15
May 4	73														73			73
May 11	259														259			259
May 18	566	3													569			569
May 25	906	50	4												960	3	3	963
June 1	2008	89	22												2119			2119
June 8	2609	270	72	2	7										2960	2	2	2962
June 15	1670	323	230	3	1036	5	1								3268			3268
June 22	1328	841	517	11	4398	69	13	15							7192			7192
June 29	749	362	1054	28	5222	125	44	140							7724			7724
July 6	66	304	834	15	2421	118	55	555	1						4369			4369
July 13	14	461	906	17	2626	103	28	914	6	1	3				5079			5079
July 20	4	261	697	8	1860	47	20	716	14	17	9	2			3655			3655
July 27	1	264	486	2	1150	21	9	450	6	91	27	1	1	1	2510			2510
Total	10273	3228	4822	86	18720	488	170	2790	27	109	39	3	1	1	40757	5	5	40762

SUPPLEMENTAL DATA

TABLE LXX.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF WATERMELONS BY STATES AND IMPORTS FOR 1930.

Week Ending	DOMESTIC																					Imports			
	Fla.	Cal.	Texas	Ariz.	Ala.	Ga.	La.	Miss.	S. C.	Va.	Ark.	Mo.	N. C.	Okla.	Ill.	Ind.	Md.	Nev.	Idaho	Wash.	Other States	Total Domestic	Cuba	Mexico	Total Imports	Total all Sources
May 17	2																					2	1	2	3	5
May 24	57	8	9																			74		2	2	76
May 31	210	62	3																			275				275
June 7	523	301	14	4																		842				842
June 14	1002	833	153	6																		1994				1994
June 21	1492	836	599	16	33	133																3109				3109
June 28	3513	722	1274	19	258	4535	1	39	60													10421				10421
July 5	1029	470	602	14	129	3387	4	40	206													5881				5881
July 12	455	547	649	10	157	4667	5	20	1194	1												7705				7705
July 19	162	670	557	2	41	2539		12	965	1	6	3	22	2								4982				4982
July 26	91	538	697	2	36	3435		4	1431	1	37	55	432	7							2	6768				6768
Aug. 2	12	528	596	3	40	2239		4	589	51	130	377	506	49	7	2	1	1				5135				5135
Aug. 9	8	244	484	4	25	2056		8	263	128	68	228	442	59	10	4	36	1	1	3		4072				4072
Total	8556	5759	5637	80	719	22991	10	127	4708	182	241	663	1402	117	17	6	37	2	1	3	2	51260	1	4	5	51265

TABLE LXXI.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CANTALOUPES BY STATES AND IMPORTS FOR 1925.

Week Ending	DOMESTIC											Imports		
	Fla.	Cal.	Texas	Ga.	Ariz.	La.	Ala.	Ark.	S. C.	Other States	Total Domestic	Mexico	Total Imports	Total all Sources
June 6	1	2590	7								2598	9	9	2607
June 13	1	3163	4	2	5						3175			3175
June 20		1757	6	5	8	1					1777			1777
June 27	1	1519	1	39	73	8	1				1642			1642
July 4	1	1829		38	607	4		82	8	1	2570			2570
Total	4	10858	18	84	693	13	1	82	8	1	11762	9	9	11771

TABLE LXXII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CANTALOUPES BY STATES FOR 1926.

Week Ending	DOMESTIC										Total Domestic
	Fla.	Ariz.	Cal.	Texas	Ga.	S. C.	Ark.	La.	Nev.	Other States	
June 12	1	26	1710	1							1738
June 19	3	63	1234	2	2					1	1305
June 26	4	93	975	2	4						1078
July 3		658	701		25	7					1391
July 10	1	1099	346	1	49	54	32	12	5		1599
Total	9	1939	4966	6	80	61	32	12	5	1	7111

TABLE LXXIII.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CANTALOUPES BY STATES AND IMPORTS FOR 1927.

Week Ending	DOMESTIC							Imports		
	Fla.	Cal.	Texas	Ariz.	Ga.	S. C.	Total Domestic	Mexico	Total Imports	Total all Sources
May 21	3	433	4	....	....	....	440	10	10	450
May 28	6	845	....	....	....	....	851	13	13	864
June 4	8	1134	....	1	....	....	1143	11	11	1154
June 11	2	2407	....	6	13	....	2428	7	7	2435
June 18	....	2230	1	36	27	....	2294	....	....	2294
June 25	2	3358	4	276	10	8	3658	....	....	3658
Total	21	10407	9	319	50	8	10814	41	41	10855

TABLE LXXIV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CANTALOUPES BY STATES FOR 1928.

Week Ending	DOMESTIC				
	Fla.	Ariz.	Cal.	Texas	Total Domestic
June 2	2	7	1922	2	1933
June 9	6	9	2230	5	2250
June 16	4	35	2094	4	2137
Total	12	51	6246	11	6320

TABLE LXXV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF CANTALOUPES BY STATES FOR 1929.

Week Ending	DOMESTIC				
	Fla.	Cal.	Texas	Ariz.	Total Domestic
May 11	2	1	....	....	3
May 18	1	51	1	....	53
May 25	2	615	4	....	621
June 1	1	1246	3	3	1253
Total	6	1913	8	3	1930

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Bulletin 226 March, 1931

UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
Wilmon Newell, Director

F. 4
27.5.52

DEVELOPMENT OF STRAINS OF CIGAR WRAPPER TOBACCO RESISTANT TO BLACKSHANK (*PHYTOPHTHORA NICOTIANAE* BREDA DE HAAN)

By W. B. TISDALE

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*In cooperation with U. S. Department of Agriculture.

DEVELOPMENT OF STRAINS OF CIGAR WRAPPER TOBACCO RESISTANT TO BLACKSHANK (*PHYTOPHTHORA NICOTIANAE* BREDA DE HAAN)

By W. B. Tisdale

Blackshank is the most destructive disease of shade-grown tobacco in the Florida-Georgia district. So far it has not proved to be of equal economic importance with flue-cured tobacco in that district because of the long-time rotation system used and of the availability of large acreages of land on which this crop has never been grown. However, flue-cured tobacco is quite susceptible to the disease and when it is planted on infested land or on land which becomes infested during the growing season, the crop is often a total failure. The disease was reported in 1930[1] to be quite serious locally with flue-cured tobacco in North Carolina. Prior to that time the disease had been reported only from Alabama, Florida, Georgia, and Virginia in the United States.[2] [4] Outside of the United States blackshank occurs in most of the older tobacco-growing countries located in the tropics or sub-tropics. It appears therefore that the disease is becoming a serious problem in the culture of all types of tobacco in countries and localities having a long growing season of relatively high temperature.

A study of the disease was begun in Gadsden County in 1922 and the general facts regarding the cause and nature of the disease and the preliminary results with control measures were discussed in previous reports.[2] [3] Since that date the work has been continued with encouraging advances in control measures, especially through disease resistance. The purpose of this paper is to describe the methods used in the development of resistant strains of cigar wrapper tobacco and to record the salient results of the experimental work.

Before discussing the details of this experimental work the cardinal points in connection with the nature and destructiveness of the disease will be given.

---

[1] In letters from F. A. Wolf and R. F. Poole.

[2] Tisdale, W. B., and J. G. Kelley. A Phytophthora disease of tobacco. Fla. Agr. Exp. Sta. Bul. (Tech.) 179:159-218. 1926. illus.

[3] Tisdale, W. B. Tobacco diseases in Gadsden County in 1922 with suggestions for their prevention and control. Fla. Agr. Exp. Sta. Bul. 166: 77-118. 1922. illus.

[4] Wingard, S. A., and James Godkin. Tobacco diseases in Virginia and their control. Va. Agr. Exp. Sta. Bul. 90:3-31. 1924. illus.

CAUSE AND DEVELOPMENT OF THE DISEASE

Blackshank of tobacco is caused by the soil-inhabiting fungus *Phytophthora nicotianae* Breda de Haan. This fungus has been found to attack roots, basal portions of the stalks and, under certain conditions, the leaves of tobacco plants at any stage of growth. In Florida blackshank is chiefly in evidence in the field after transplanting, although it may appear occasionally in the plant bed, especially if the bed is flooded by drainage water from infested fields after the plants are well advanced. Its failure to appear regularly in the plant beds in Florida is because the temperature is usually too low for infection to occur while the seedlings are in the beds. In certain countries tobacco seed is sown at a time when the soil temperature is favorable for infection by *Phytophthora nicotianae.* Under such conditions the disease may be a limiting factor in the production of tobacco seedlings. It has been reported to be especially destructive in plant beds in Porto Rico.[5]

Plants usually succumb to attacks of the disease within a few days, if they are transplanted to infested soils late in the season after the soil temperature is relatively high. On the other hand, if the plants are transplanted in the tobacco district of Florida before April 1, they grow vigorously until they are from 10 to 18 inches high before showing signs of the disease. This is because the parasite is unable to invade the host aggressively until the soil temperature reaches 20°C. and above. The optimal temperature for development of the disease has not been determined but information obtained indicates that it is several degrees above 20°C.

Under conditions of high humidity and favorable temperature the fungus attacks the stems and leaves of tobacco seedlings and produces a characteristic dark, wet rot similar to late blight of potato. With older plants the disease is primarily a dry rot of the roots and basal portion of the stem, although the lower leaves may be attacked during prolonged rainy periods. The fungus usually attacks first the tap-root or main laterals and rapidly invades and kills all parts of the root system and the lower portion of the stalk. This leads to sudden wilting and the progressive browning and death of the aerial parts of susceptible plants within a few days. Less susceptible plants may wilt during the day and recover at night for some time and finally persist in a stunted condition and blossom prematurely.

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[5] Nolla, J. A. B. The black shank of tobacco in Porto Rico. (Abstract) Phytopath. 19:93-94. 1929.

When the soil is once infested, the fungus seems capable of persisting almost indefinitely after the land has been abandoned for tobacco culture. The results of several trials have shown that the fungus is present in sufficient amount after six or eight years to cause heavy loss when the land is planted again to a susceptible variety. On the other hand, trials in certain fields have indicated that the infestation was materially reduced after a period of from one to three years. Furthermore, differences in severity of the disease have been observed on certain types of soil from year to year, but all the factors which may cause this erratic behavior have not been ascertained. Although the possible variation in the pathogenicity of the parasite has not been overlooked, cultures of the organism isolated from diseased tobacco plants growing in different types of soil and in different localities have proved equally pathogenic in inoculation experiments.

In any event, the period of survival in the soil is too long for any rotation system to be practical with tobacco grown under slat shade. Furthermore, the various methods of soil treatment have proved equally impractical for eradicating the parasite. On account of the numerous agencies which may disseminate the parasite from field to field and the rapid progress of the disease in a field once the soil has become infested, the culture of susceptible varieties of shade tobacco is fraught with great risk on farms or in localities which have infested areas. It is therefore natural that with the increasing importance of the disease a keen demand has arisen for resistant strains conforming in type and quality to the demands of the trade.

DEFINITION OF THE PROBLEM

As already noted[6, 7], resistant strains of the local variety, Big Cuba, have been secured by selecting and propagating self-pollinated individuals that survived on uniformly infested soils. By the same method resistant strains of a Cuban variety (Little Cuba), a variety (Dubek) from Russia, and a variety (Santiago) from Java have been developed, but none of these varieties

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[6] Tisdale, W. B., and J. G. Kelley. Loc. Cit.

[7] Tisdale, W. B. Progress in the control of black shank of tobacco through disease resistance, (Abstract) Phytopath., 19:93. 1929.

is satisfactory for growing under local conditions. On the other hand, no progress has been made in the development of resistant strains of the variety known as Connecticut Round Tip and several others which possess desirable quality for cigar wrappers, as no individuals survived on uniformly infested soil.

Connecticut Round Tip was introduced from Connecticut into Florida in 1921 and from the first the yield and quality of leaf produced proved superior to the local variety, Big Cuba. Immediately, the acreage of the Round Tip was increased and that of Big Cuba was decreased in proportion until in 1924 practically the entire acreage was planted to Round Tip. This general planting of Connecticut Round Tip was concomitant with a severe epidemic of blackshank which resulted in a complete failure of the crop in many fields and a very heavy reduction in yield for the entire district. This disastrous epidemic of blackshank convinced the growers that it was very hazardous to make further attempts to grow Connecticut Round Tip on old shade lands. Many growers planted the crop under cloth shade on new land each year, but the quality of leaf proved less desirable in many cases and the crop did not always escape loss from the disease. Since a market had been created for the Connecticut Round Tip type and quality of leaf, the jobber and manufacturer offered the grower no encouragement to return to the Big Cuba type. Therefore, the problem presented was to secure a resistant strain which would produce a good yield of leaf that would meet the demands of the trade. The greatest possibility for accomplishing this result seemed to lie in crossing the resistant strains of mediocre quality of leaf or low yield with susceptible strains of good yield and superior quality of leaf.

METHODS OF EXPERIMENTATION

Tobacco blossoms are self-pollinated but when grown in the open they may be cross-pollinated by insects and humming birds. Therefore, in selecting plants to perpetuate certain characters, it is only necessary to protect the blossoms from cross-pollination. This was conveniently done by covering the inflorescence with a 12-pound sulphite paper bag until the seed were mature. As a rule, fewer seed were obtained from plants thus treated than from unbagged plants, but in most instances ample seed were obtained from each plant for extensive tests. There was no apparent reduction in vigor of the plants resulting from selfing, even though some strains had been selfed repeatedly for eight generations. However, there were some deviations in growth habits from the commercial variety. One of the chief reasons for these deviations probably is that the commercial varieties are usually not uniform for leaf characters and the disease reduced the plants to a very small group within which the original selections were made, thus leaving little opportunity to select for conformity to the original predominant type of the commercial variety.

The initial selections of Big Cuba were made in a commercial field in which blackshank was very severe. Seed from each self-pollinated plant were saved separately and planted the following season on a steam-sterilized bed. A 6-inch board was placed on edge between adjacent lots of seed to prevent mixing. Seedlings from each lot were transplanted to thoroughly infested soil in adjacent rows. Seed of the best plants from the most resistant rows were again saved and the process was repeated until a highly resistant strain was developed. Except for certain details, this method was employed with the progenies resulting from crosses.

In all the work, plants as near the same size as possible were used for field trial and whenever possible all strains tested in one field were transplanted on the same day. Whenever the number of plants was sufficient, the tests were duplicated each year on two different fields. The soils used in the trials belonged to the Norfolk and Tifton series and in most cases the plots were located on both types each year. The land was fertilized and cultivated according to general practices. Rows of the commercial Big Cuba or Connecticut Round Tip variety were planted across the field at intervals for checks. The prevalence of blackshank among the selections was recorded at intervals of 10 to 14 days throughout the growing season. External condition of the plants above ground only was used to determine the percentage of blackshank during the growing season. After the first year one or two primings of leaves were kept from the most resistant selections for comparing quality. This made possible the elimination of the strains unsuited for cigar wrappers.

The results obtained on the two fields in any one year did not always check, although the selections which were most resistant in one field usually showed highest resistance in the other. The results shown in the tables are the average of the results obtained in the two fields.

A very simple and easy method was used in making crosses. Some of the first blossoms which appeared were used for most of the crosses. The emasculating and pollinating operations were performed on the day before the blossoms were ready to open. Pollen from blossoms of the same stage of development as the ones pollinated was used. At that time the anthers were not ruptured but the pollen was mature and could be removed easily and applied to the stigma with a sharp pointed scalpel or forceps. This method was very successful and required the minimal time for the operation. Pollen from blossoms one day older gave equally successful results, but there was danger of obtaining mixed pollen unless the blossoms had been bagged previously. The cross-pollinated blossoms were protected with a bag which was left in place until the seed were harvested. In order to expedite the work the F_1 plants, except those from the first cross, were grown in the greenhouse during the winter months on steam-sterilized soil. The F_2 and subsequent generations were tested in the field on thoroughly infested soil, except in one or two instances, as indicated in the text, a few plants were grown in the greenhouse during the winter.

As a rule, several different types of plants appeared in the second generation, and in some cases the individuals which apparently possessed the most desirable leaf characters succumbed to the disease before they reached maturity. In practically every instance some of the F_2 plants began to show signs of the disease within a few weeks after transplanting, while others succumbed at intervals throughout the growing season. Many plants which showed no signs of the disease during the growing season were found to have part of the root system dead when the seed were harvested. In most instances of this nature, infection appeared to have developed after the plants were mature. The root systems of all selected plants were examined at the time the seed were harvested and, as a rule, seed were saved for further trial only from those which showed no root infection. Whenever a plant was outstanding for desirable leaf characters, seed were saved from it, even though part of the roots were diseased. The progenies of several such plants proved as resistant as those of plants with healthy root systems.

No effort has been made to study the ratio of inheritance of the resistant character since, at the time most of the crosses were made, it was apparent that none of the parent strains used were homozygous for the resistant character. Because of the urgent demand for a resistant strain or variety of the cigar wrapper type, special consideration has been given to the individuals and their progenies which showed greatest promise in this respect. Progenies of crosses which possessed undesirable qualities for cigar wrappers were discarded as soon as the quality could be determined, even though they were highly resistant.

RESISTANT STRAINS FROM COMMERCIAL VARIETIES

Since the beginning of the work, seed of different varieties of tobacco grown in the United States and many from several foreign countries have been obtained from time to time and tested on infested soil. These included varieties of virtually all of the different commercial types of *Micotiana tabacum* Linn., one wild variety from Guatemala and one from Matacumbe Key, Florida, and one variety of *Nicotiana rustica* Linn. These tests were conducted in an effort to determine whether any resistant varieties existed in nature so they might be used as a basis, through crossing, for developing a resistant strain suitable for cigar wrappers when grown under local conditions.

Nicotiana rustica proved highly resistant from the beginning. On the other hand most of the varieties of *Nicotiana tabacum* tested, except the ones from which resistant strains have been obtained and discussed in this paper, were almost completely susceptible. All efforts to cross *Nicotiana rustica* with varieties of *Nicotiana tabacum* were unsuccessful. With certain varieties of *Nicotiana tabacum* a few plants remained healthy in the first test but their progenies succumbed when planted on infested soil, showing that the few plants merely escaped infection the first year. On the other hand, an occasional plant of the local variety Big Cuba, Little Cuba (Cuban), and Santiago (Java) remained healthy on infested soil throughout the season and the progenies of several of these selfed individuals showed increased resistance in the first and subsequent generations. However, completely resistant strains of these varieties have not been obtained after selecting for several years, although several of the strains showed no symptoms of disease until the approach of harvest season. The susceptible varieties used as checks usually showed 100 percent blackshank before that time.

BIG CUBA

The Big Cuba variety of cigar wrapper tobacco is said to have originated from a cross between Sumatra and Cuban varieties which were grown extensively in Gadsden County before 1900. It was the main variety grown under shade from about 1909 to 1923. Many of the growers had saved their own seed from year to year and as a result there were noticeable differences in the color, size, and number of leaves among the strains from different farms. In order to facilitate the identification of selections from different sources they were given different stock numbers. Thus, the letter, as A, E, H, P and Se, in the progeny number represents the source of the selection. The first number, as 22, represents the year the seed was saved and the third number is the number of the individual plant in the series.

The initial selections of Big Cuba for resistance were made in 1922 in two commercial fields in which blackshank was very severe and uniformly distributed. Also, four plants were selected on non-infested soil that year because they showed outstanding leaf characters. The progenies of these selected plants were tested for resistance to blackshank in 1923 in infested soil. A report of the first three years' results with these selections is given in a previous publication[8] but in order to show the general progress in the development of resistant strains, they are included in Table I with the data obtained through 1930.

The relative resistance and general characters of growth of this resistant strain may be seen in Fig. 1. The leaf characters are quite uniform, although they differ in certain details from the commercial variety of Big Cuba from which it was developed. As may be seen in Fig. 2[9], the angle formed by the lateral veins and midrib is almost a right angle. It has been reported that leaves possessing this character cannot be stripped satisfactorily by machinery. Another objection which has been given by cigar manufacturers against Big Cuba and the resistant strain is that the cured leaf is sleazy and breaks badly after it is wrapped on cigars. Because of these two undesirable characters there is only a small demand for Big Cuba tobacco. However, the quality of the resistant strain appears as good as that of the commercial variety when grown under similar conditions.

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[8] Tisdale, W. B., and J. G. Kelley. Loc. Cit.

[9] All pictures used in this bulletin to illustrate leaf characters were made on the same scale.

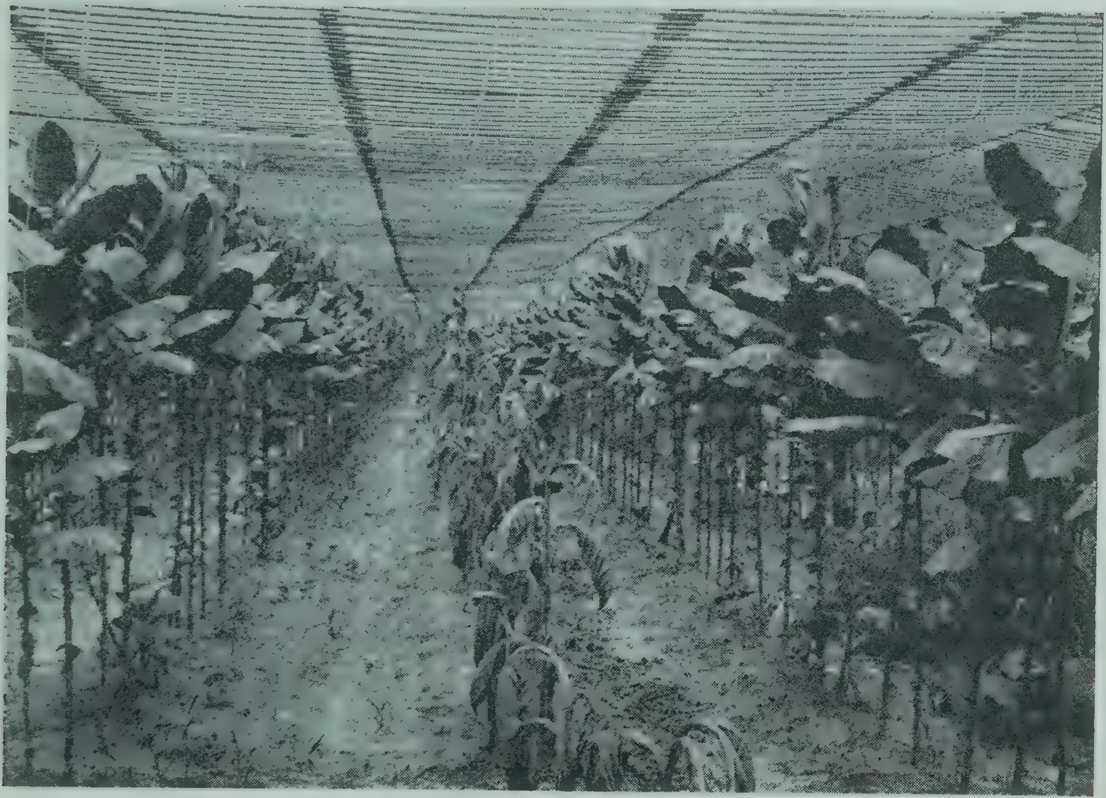

Fig. 1.—Resistant Big Cuba tobacco (left and right) and susceptible Connecticut Round Tip (center) in Phytophthora-infested soil in 1927. Photographed after most of the leaves had been harvested.

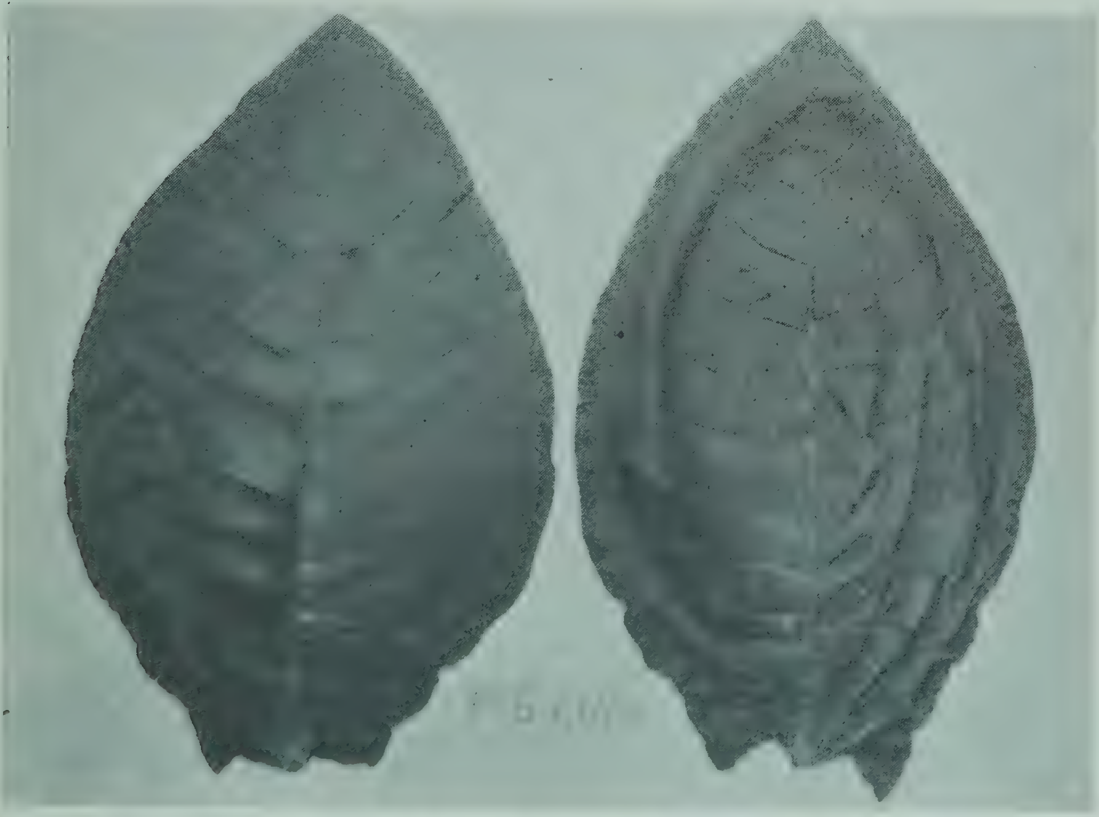

Fig. 2.—The fifth (left) and tenth leaves from a plant of the resistant strain P of Big Cuba tobacco. Note that angle formed by lateral veins and midrib is almost a right angle.

TABLE I—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES OF STRAINS SELECTED FROM THE BIG CUBA VARIETY OF TOBACCO WHEN GROWN IN INFESTED SOIL.

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
		1923			
Commercial Stock	Big Cuba (check)	520	18	59	23
First	P-22- 1	456	6	64	30
	P-22- 3	112	81	14	5
	P-22- 4	43	88	12	0
	E-22- 2	431	74	21	5
	E-22- 3	71	5	61	34
	E-22- 4	148	7	40	53
	E-22- 6	61	23	66	11
	E-22-10	287	35	33	32
	E-22-14	400	76	17	7
	E-22-15	58	7	55	38
	E-22-16	150	15	53	32
	E-22-18	113	15	65	20
	E-22-19	62	14	37	49
	E-22-21	457	42	35	23
	E-22-22	62	39	42	19
	E-22-24	64	7	45	48
	E-22-27	607	29	38	33
	E-22-28	376	9	47	44
	E-22-34	278	15	51	34
	E-22-35	84	90	5	5
	E-22-36	259	8	52	40
	A-22- 5*	64	88	10	2
	A-22-22*	96	0	40	60
	H-22-16*	153	72	18	10
	Se-22-12*	28	61	32	7

*These selections were made on uninfested soil.

		1924			
Commercial Stock	Big Cuba (check)	586	4	3	93
Second	P-23- 1	157	23	4	73
	P-23- 4	205	34	2	64
	P-23- 6	180	36	12	52
	P-23- 8	154	26	7	67
	P-23- 9	96	34	0	66
	P-23-10	178	30	8	62
	P-23-11	179	43	7	50
	A-23- 3	205	19	3	78
	A-23- 4	177	12	7	81
	A-23-16	229	0	3	97

TABLE I—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES OF STRAINS SELECTED FROM THE BIG CUBA VARIETY OF TOBACCO WHEN GROWN IN INFESTED SOIL.—Continued

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
	Ho-23-1	151	23	6	71
	Se-23-3	209	4	3	93
	H-23- 2	211	1	2	97
	H-23- 3	215	8	0	92
	E-23- 2	164	12	5	83
	E-23- 4	175	5	3	92
	E-23- 8	165	10	5	85
	E-23-14	211	10	2	88
	E-23-15	178	8	6	86
	E-23-16	170	16	2	82
	E-23-21	167	3	2	95
	E-23-27	120	5	3	92
	E-23-34	186	11	4	85
	E-23-42	166	0	2	98
	E-23-43	178	3	2	95
1925					
Commercial Stock	Big Cuba (check)	791	67	14	19
Third	P-24- 1	293	9	0	91
	P-24- 3	214	47	16	37
	P-24- 6	213	49	19	32
	P-24- 8	108	45	18	37
	P-24-19	120	50	12	38
	P-24-32	210	54	5	41
	P-24-33	114	24	5	71
	P-24-41	209	58	16	26
	P-24-44	111	34	2	64
	P-24-51	210	67	10	23
	P-24-52	201	40	15	45
	P-24-54	207	45	22	33
	P-24-61	202	28	6	66
	E-24- 1	193	38	16	46
	E-24- 2	215	13	15	72
	E-24- 6	211	48	21	31
	E-24- 7	205	50	7	43
	A-24-22	202	40	19	41
	A-24-24	113	20	4	76
	A-24-26	203	17	24	59
	A-24-27	202	35	15	50
	A-24-30	206	24	15	61
	A-24-35	205	28	22	50
	A-24-36	205	38	17	45
	H-24- 1	111	22	11	67
	H-24- 8	210	22	11	67

TABLE I—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES OF STRAINS SELECTED FROM THE BIG CUBA VARIETY OF TOBACCO WHEN GROWN IN INFESTED SOIL.—Continued

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
Fourth	P-25-3*	111	57	16	27
	P-25-4*	296	56	12	32
	P-25-5*	290	63	14	23
	P-25-8*	241	54	11	35
	P-25-10*	148	56	18	26
	P-25-11*	221	70	14	16
	P-25-12*	212	56	19	25
	P-25-14*	106	42	8	50
		1926			
Commercial Stock	Big Cuba (check)	225	2	4	94
Fifth	P-26- 1	95	84	4	12
	P-26- 2	215	62	4	34
	P-26- 3	203	46	6	48
	P-26- 4	204	4	2	94
	P-26- 5	203	72	7	21
	P-26- 7	90	80	4	16
	P-26- 9	208	70	11	19
	P-26-12	205	63	15	22
	P-26-13	209	65	9	26
	P-26-23	96	70	6	24
		1927			
Commercial Stock	Conn. Round Tip (check)	282	0	0	100
Sixth	P-27- 5	500	69	11	20
	P-27- 7	471	71	9	20
	P-27- 9	95	98	1	1
	P-27-10	477	82	0	18
	P-27-13	478	74	8	18
	P-27-15	464	86	2	12
		1928			
Commercial Stock	Conn. Round Tip (check)	662	0	2	98
Seventh	P-27-20	73	93	4	3
	P-27-23	73	97	0	3
	P-27-26	277	94	0	6

*Parents of these selections were grown in greenhouse during winter of 1924-25 in sterilized soil from seed of progeny P-24-1 and P-24-4.

TABLE I.—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES OF STRAINS SELECTED FROM THE BIG CUBA VARIETY OF TOBACCO WHEN GROWN IN INFESTED SOIL.—Continued

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
	P-27-27	212	88	2	10
	P-27-29	226	90	4	6
	P-27-32	125	94	2	4
	P-27-33	66	95	0	5
	P-27-37	170	92	6	2
	P-27-38	94	93	4	3
	P-27-39	106	100	0	0
	P-27-40	79	89	2	9
	P-27-41	99	95	5	0
		1929			
Commercial Stock	Conn. Round Tip (check)	273	0	0	100
Eighth	P-28- 2	70	99	1	0
	P-28- 4	89	89	9	2
	P-28-10	203	87	7	6
	P-28-11	109	92	2	6
	P-28-14	197	90	5	5
	P-28-15	206	90	4	6
	P-28-17	203	90	8	2
		1930			
Ninth	P-29- 2	60	72	18	10
	P-29- 5	65	65	20	15

It may be observed from the results given in Table I that the progress made in the isolation of resistant strains of the Big Cuba variety was very gradual. Also, there was some variation in the degree of resistance from year to year after the fifth generation. This was especially noticeable in 1930 when the two selections tested showed much lower resistance than in 1928 or in 1929. It so happened that the rainfall was light and prevailing temperatures were high during the growing season of 1930. The same conditions existed in 1925. However, none of the strains had shown a high degree of resistance prior to 1925. It is possible, therefore, that the unfavorable conditions for growth of the tobacco plant also exerted an injurious effect upon the resistant character. This theory is supported by the high percentage of plants which showed symptoms of the disease in those years but were not killed.

It may be observed also that all of the original selections except those from one source were dropped after the third year. Other selections were made in commercial fields from time to time but in most cases their progenies showed either little or no resistance or inferior quality of leaf, and the results of the tests are not shown.

LITTLE CUBA

This variety of tobacco was originally introduced from Cuba and was grown extensively in the State until the development of artificial shade in 1896. The quality of leaf of this variety is considered very good, but on account of the small number and size of leaves, resulting in low yield, it could not be grown profitably under shade and its culture was discontinued except on small acreages. Although this variety had been grown in the State for years and propagated from mass selected seed, it was fairly uniform for leaf characters.

The original selections of Little Cuba for resistance to blackshank were made in 1923 in a 5-acre commercial field in which there were evidences of only slight blackshank infection. The progeny of one of these selected plants was tested on infested soil in 1924. At the end of the season 80 percent of the plants were living and 50 percent were healthy.

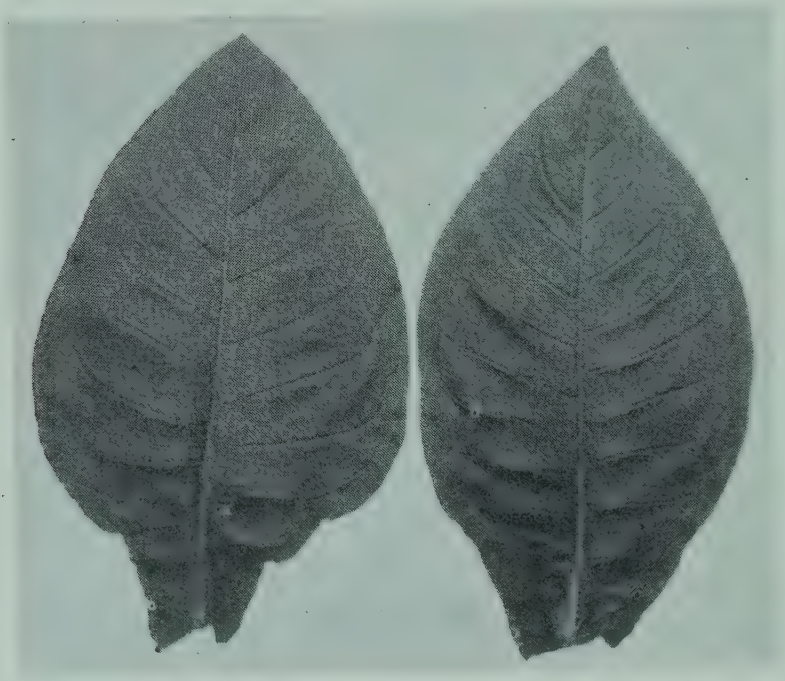

Fig. 3.—The fifth (left) and tenth leaves from a plant of resistant Little Cuba tobacco. Note that angle formed by lateral veins and midrib is slightly more acute than that of resistant Big Cuba.

Several selections were made from this strain but only two of them were tested in 1925. The tests were made on two farms and in each case both selections showed a high percentage resistance to blackshank, averaging 85 percent living and 74 percent healthy.

The trials of this strain in 1926 included a similar Cuban variety (Havanensis), the seed of which was obtained from Cuba in the summer of 1925. Several selections were tested that year in the same field used in 1925. The results of these trials and those obtained in 1927 are shown in Table II. The general leaf characters of this variety are shown in Fig. 3.

TABLE II.—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES OF STRAINS SELECTED FROM THE "LITTLE CUBA" VARIETY OF TOBACCO WHEN GROWN IN INFESTED SOIL.

Generation	Progeny No.	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
		1926			
Commercial Stock	Big Cuba (check)	512	4	2	94
Commercial Stock	Havanensis	149	68	5	27
Third	L. C. 25- 1	199	67	3	30
	L. C. 25- 3	105	43	5	52
	L. C. 25- 4	211	75	2	23
	L. C. 25- 6	202	65	5	30
	L. C. 25- 7	214	58	10	32
	L. C. 25- 8	153	66	7	27
	L. C. 25-10	148	54	8	38
	L. C. 25-11	200	47	4	49
	L. C. 25-12	109	20	7	73
	L. C. 25-13	210	71	6	23
		1927			
Commercial Stock	Conn. Round Tip (check)	319	0	0	100
Second	Hav. 26- 2	178	85	4	11
	Hav. 26- 3	125	90	5	5
Fourth	L. C. 26- 2	72	83	3	14
	L. C. 26-12	73	88	1	11

Only one of the resistant strains of the Little Cuba variety was planted each year after 1927 because of the small number and size of the leaves. It was planted to cross with certain other varieties.

SANTIAGO (JAVA)

In 1927 seeds of several varieties of tobacco were obtained from Java through the United States Bureau of Plant Introduction. Plants of these varieties were tested on blackshank-infested soil in the summer and fall of that year. All varieties except Santiago proved completely susceptible to the disease and only two plants of that variety remained healthy and vigorous. These two plants were self-pollinated and their progenies when tested on infested soil in 1928 showed 78 and 84 percent healthy plants, respectively, at the end of the season. Three plants which possessed the largest leaves were selected from the most resistant strain and their progenies were tested in 1929 on infested soil. At the end of that season two of the strains showed 96 percent healthy plants and the third one 94 percent.

Although this variety produced a leaf which possessed fair quality for cigar wrappers, it was considered unprofitable to grow under Florida conditions because of the small number and size of the leaves and no further tests were made. However, it was crossed with other varieties in an effort to combine its resistance with larger leaves.

DUBEK (RUSSIA)

In 1926 seeds of several varieties of tobacco were obtained from Russia and they were planted in infested soil in 1927. Most of them resembled Turkish varieties but no information was supplied concerning their origin or purpose for which grown. All of these varieties, except Dubek, succumbed very quickly to blackshank. At the end of the season 78 percent of the plants of Dubek were living and 66 percent of them were healthy. Although the variety showed no possibilities for cigar wrappers, a few of the plants were self-pollinated and the progeny of one of them was tested on infested soil in 1928. This selected strain proved very resistant to blackshank; 100 percent of the plants were living and 96 percent were healthy at the end of the season. The leaf characters were very uniform and the average number of leaves per plant was 32. Since the leaves were entirely too small for cigar wrappers, the strain was not given further trial. However, it has been crossed with other varieties and the progenies are being tested for resistance and quality of leaf.

RESISTANT STRAINS FROM CROSSES

During the course of these studies numerous crosses have been made between several different varieties and strains of tobacco. The progenies of several of the earlier crosses were either completely susceptible to blackshank or the quality of the leaf was not suitable for cigar wrappers. The tests of such strains extended over a period of from one to four years only. Furthermore, several crosses have been made during recent years but the progenies have not been tested sufficiently to determine their resistance to blackshank and quality of leaf. Consequently, results of the tests with such strains are not included in this report. Only the resistant strains which have shown some possibility for cigar wrappers are discussed. Although most of these strains have been grown commercially to some extent and certain ones have proved fairly satisfactory for resistance and quality, the tests have not been made over a sufficient number of years to warrant the recommendation of any particular strain. Furthermore, the showing made by progenies of some of the more recent crosses indicates that they may be superior to the resistant strains now in commercial use and will supersede them as soon as their value can be established. None of the strains has been given a variety name, and all are discussed under the number used to designate the F_1, as Nos. 1, 94, and 301.

NO. 1

The first artificial crosses in connection with the experiments herein reported were made in 1923 between Big Cuba and Connecticut Round Tip. In these crosses Big Cuba was the male parent and Connecticut Round Tip the female. The Big Cuba plants used in the crosses were growing on infested soil and were individuals of the most resistant strain tested that year. The Connecticut Round Tip was growing on uninfested soil. Ten crosses were made and the hybrid seed were assigned the numbers 1 to 10[10], inclusive.

The F_1 progenies of these crosses were tested in 1924 in the field in thoroughly infested soil. All plants from eight of the crosses succumbed to the disease and only a few plants of the remaining two, numbers 1 and 6, survived. These plants were self-pollinated and the F_2 progenies were tested on infested soil in 1925. Although the percentage resistance of the F_2 was low, seed were saved from the few healthy plants for testing the F_3

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[10] Throughout this paper the initial figure, as 1, 6, and 94, of the progeny number designates the number assigned to the hybrid seed for the F_1 plants. Later generations appear as 1-1, 6-1 and 94-1 for F_2 and 1-1-1 to 1-1-3 or as many individuals as were selected in the series for F_3. Each year the progeny number increases by one figure, the figure being appended on the right. By this method the progeny number indicates the generation of the plants being grown.

progeny. Seed from one of the F_2 selections were planted in the greenhouse during the winter of that year, and the progeny of one of the greenhouse plants was tested in 1926 alongside of sister strains of the parent. The results of these and succeeding trials are shown in Table III.

TABLE III.—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES FROM CROSSES BETWEEN A RESISTANT STRAIN OF BIG CUBA AND SUSCEPTIBLE CONNECTICUT ROUND TIP TOBACCO PLANTS WHEN GROWN IN THE FIELD IN INFESTED SOIL.

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season: Healthy Percent	Condition at End of Season: Diseased Living Percent	Condition at End of Season: Diseased Dead Percent
	1925				
Commercial Stock	Big Cuba (check)	509	8	5	87
Second	1-1	203	10	11	79
	6-1	210	7	9	84
	6-3	220	9	7	84
	Conn. Round Tip	302	0	1	99
	(check)	302	0	1	99
	1926				
Commercial Stock	Conn. Round Tip (check)	204	0	0	100
Third	1-1-1	127	41	19	40
	1-1-3	153	25	8	67
	1-1-3g*	208	36	6	58
	6-1-1	217	31	4	65
	1927				
Commercial Stock	Conn. Round Tip (check)	319	0	0	100
Fourth	1-1-2-1**	215	0	0	100
	1-1-3-1	122	42	18	40
	1-1-3-4	82	43	27	30
	1-1-3-5	127	59	19	22
	1-1-3g-1	112	48	18	34
	1-1-3g-2	120	64	16	20
	1-1-3g-4	71	77	9	14
	1-1-3g-5	204	83	4	13
	6-1-1-1	194	82	4	14
	6-3-2-1	199	39	8	53

*Parent of this strain was grown in greenhouse during winter of 1925-26. In this case the letter "g" was added instead of another generation number.

**Parent of this strain was grown in greenhouse during winter of 1926-27.

TABLE III.—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES FROM CROSSES BETWEEN A RESISTANT STRAIN OF BIG CUBA AND SUSCEPTIBLE CONNECTICUT ROUND TIP TOBACCO PLANTS WHEN GROWN IN THE FIELD IN INFESTED SOIL—Continued.

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
	1928				
Commercial Stock	Conn. Round Tip (check)	212	0	5	95
Fifth	1-1-3-4-1	46	98	0	2
	1-1-3-5-2	108	92	2	6
	1-1-3-5-6	84	73	3	24
	1-1-3g-5-3	25	100	0	0
	1-1-3g-5-4	92	96	0	4
	6-1-1-1-1	264	89	4	7
	6-3-2-1-1	187	68	14	18
	6-3-2-1-2	160	33	34	33
	6-3-2-1-3	160	39	37	24
	6-3-2-1-5	148	65	10	25
	1929				
Commercial Stock	Conn. Round Tip (check)	273	0	0	100
Sixth	1-1-3g-5-4-1	201	95	1	4
	1-1-3g-5-4-2	197	98	1	1
	1-1-3g-5-4-3	202	98	0	2
	1-1-3g-5-4-4	193	99	0	1
	6-3-2-1-1-1	35	94	0	6
	6-3-2-1-2-1	44	89	11	0
	6-3-2-1-5-2	80	100	0	0
	6-3-2-1-5-3	31	100	0	0
	6-3-2-1-5-4	114	93	0	7
	1930				
Commercial Stock	Conn. Round Tip (check)	333	0	0	100
Seventh	1-1-3g-5-4-2-3	65	86	12	2
	1-1-3g-5-4-2-4	66	92	3	5
	1-1-3g-5-4-4-1	64	83	10	7
	1-1-3g-5-4-4-2	64	91	0	9

As may be seen from Table III, many of the F_5 and F_6 selections of No. 1 were practically 100 percent resistant to blackshank in 1928 and in 1929 (Fig. 4), but all of the F_7 selections tested in 1930 showed some susceptible plants. It is also noticeable that there was no sudden segregation into resistant and susceptible strains, but rather a gradual increase in degree of resistance from year to year. The F_5 and F_6 selections from these crosses appeared very uniform for leaf characters and there were only slight differences in leaf characters between the sister selections of each cross. However, there were marked differences in the leaf characters between the No. 1 and No. 6 strains. The leaves of the No. 6 strain were unsuited for cigar wrappers, because they were narrow in proportion to the length and strongly tapered toward each end and when cured the color was dark. The leaves of the No. 1 strain are considerably larger than either parent when grown under similar conditions, but the general shape and venation of the leaf are intermediate between the two (compare figures 2, 5, and 6). The strain averages only 21 leaves per plant, but the large size of the leaves insures a heavy yield. The leaf is thin and light colored when cured, but the veins are somewhat coarse, as would be expected from the size of the leaf.

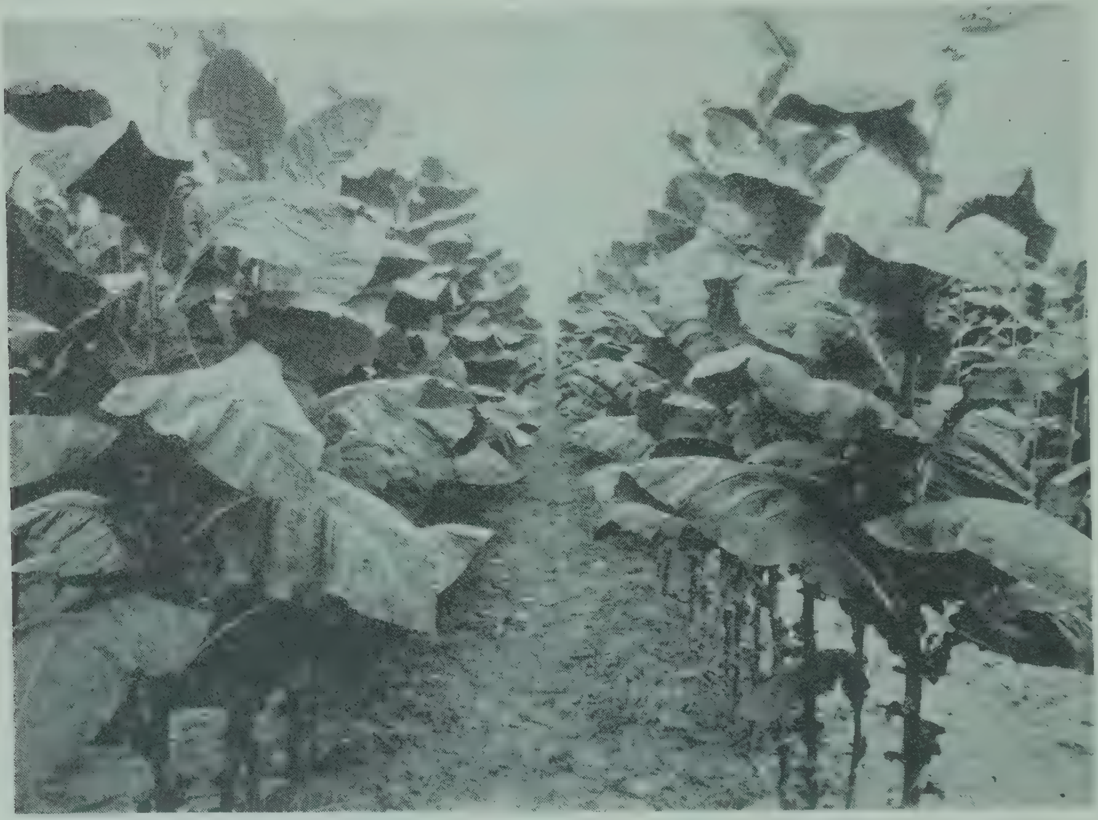

Fig. 4.—Two selections of the resistant strain No. 1 in Phytophthora-infested soil in 1929. Photographed after about one-third of the leaves had been harvested.

This No. 1 strain was tested on a small commercial scale for the first time in 1930. The yield and color of the cured leaf was reported as being fairly satisfactory, but it was reported to have a coarse texture and an unusually bitter taste. The strain will be tested further to determine whether this bitter principle is an inherent character. If this should be the case, the strain would be worthless for cigar wrappers.

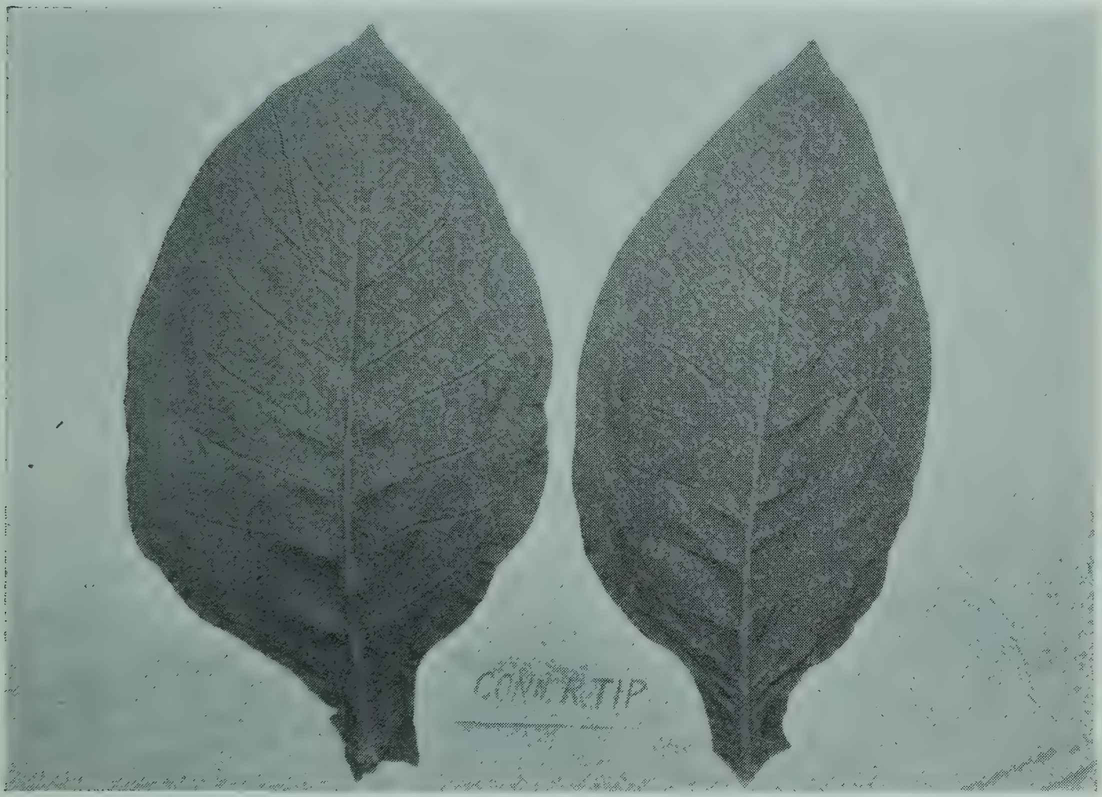

Fig. 5.—The fifth (left) and tenth leaves from a plant of Connecticut Round Tip tobacco. The acute angle formed by the lateral veins and midrib of this variety is said to be very desirable.

R

In 1924 the owner of a farm on which one of the test plots was located set one row—325 plants—of Connecticut Round Tip through perforated mulch paper. This row was adjacent to a row of partially resistant Big Cuba. The mulch paper appeared to have no effect whatever on the rate of development of blackshank, since all of the plants were dead by the end of the season. However, one plant matured some seed before it died. The leaves of this plant were typical of the Connecticut Round Tip variety, as far as was determined. The seed were saved and assigned the letter R to designate it as a selection of Connecticut Round Tip. The inflorescence had not been bagged.

In 1925, 224 plants from this selection were tested in the field for resistance to blackshank. By the time the plants had attained a height of one foot it was evident that only a few of them possessed characters typical of the Connecticut Round Tip variety. The others possessed leaf characters somewhat similar to Big Cuba. This was especially true of the upper leaves of the mature plants. As the season advanced the plants which most closely resembled Connecticut Round Tip succumbed to blackshank, while a number of the others remained healthy and vigorous. At the end of the season 54 percent of the 224 plants were living and 45 percent were healthy. Therefore, it was assumed that the plant was pollinated with pollen from the partially resistant strain of Big Cuba growing adjacent to it in 1924. This assumption was supported in 1926 by the fact that typical Big Cuba plants appeared in the F_2 progeny of one of the selected seed plants. Several selections of the strain were grown in the F_2 in 1926 and in succeeding generations successively through 1930 in infested soil and the results are shown in Table IV. This strain was numbered and handled as a selection instead of a cross because nothing definite was known concerning the pollination.

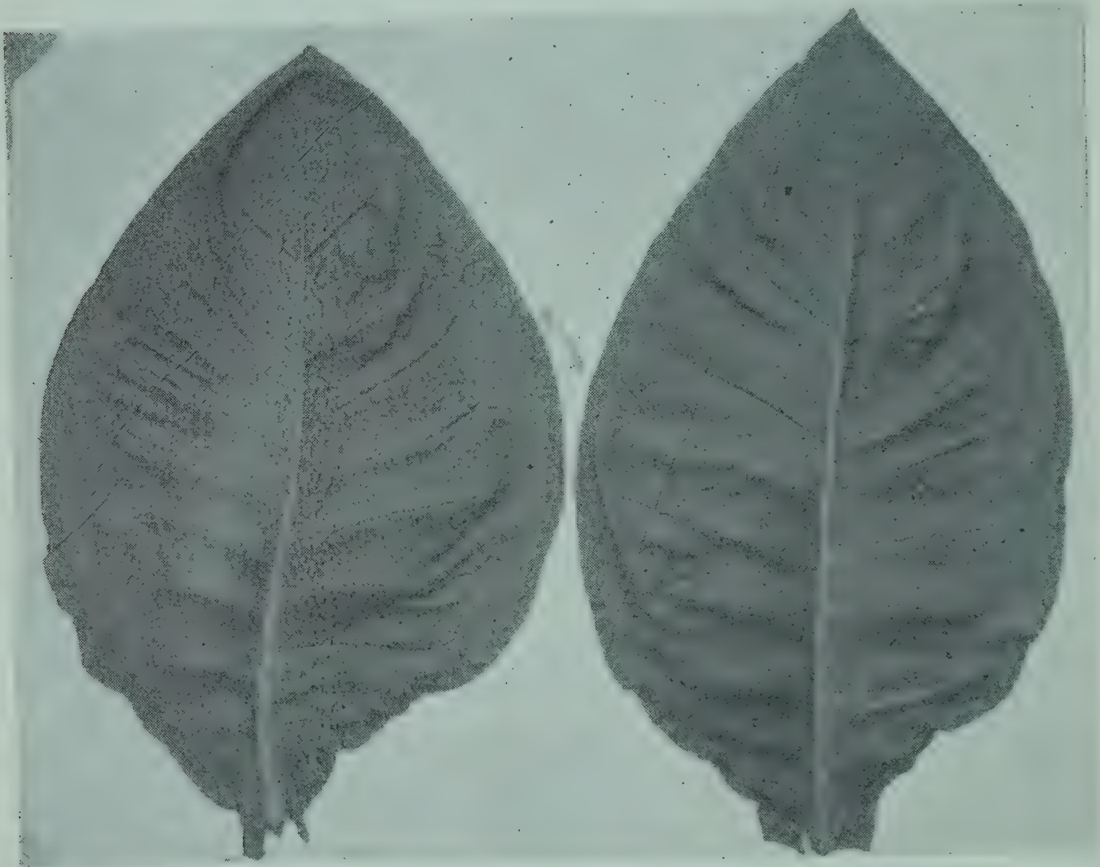

Fig. 6.—The fifth (left) and tenth leaves from a plant of the resistant strain No. 1. The angle formed by the lateral veins and the midrib is slightly less acute than that of the Connecticut Round Tip variety.

TABLE IV.—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES FROM A PROBABLE NATURAL CROSS BETWEEN PARTIALLY RESISTANT BIG CUBA AND SUSCEPTIBLE CONNECTICUT ROUND TIP TOBACCO PLANTS WHEN GROWN IN THE FIELD IN INFESTED SOIL.

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
1926					
Commercial Stock	Conn. Round Tip (check)	258	0	1	99
Second	R-25-1	71	90	0	10
	R-25-2	204	44	6	50
	R-25-3	210	76	1	23
	R-25-4	150	76	1	23
1927					
Commercial Stock	Conn. Round Tip (check)	601	0	0	100
Third	R-26-1	442	73	9	18
	R-26-2	421	55	20	25
	R-26-3	423	75	6	19
	R-26-4	311	53	11	36
	R-26-6	441	66	15	19
	R-26- 7	426	66	12	22
	R-26- 9	349	70	11	19
	R-26-13	358	65	18	17
	R-26-15	67	79	5	16
	R-26-16	173	72	10	18
	R-26-20	211	77	8	15
	R-26-21	368	76	6	18
	R-26-22	280	73	10	17
	R-26-24	76	61	28	11
	R-26-25	447	76	7	17
	R-26-26	438	75	4	21
1928					
Commercial Stock	Conn. Round Tip (check)	662	0	2	98
Fourth	R-27-1g*	116	80	11	9
	R-27-6g*	100	73	14	13
	R-27-8g*	25	100	0	0
	R-27-2	238	85	4	11
	R-27-5	42	95	0	5
	R-27-7	80	87	1	12
	R-27-8	81	89	0	11
	R-27-9	78	73	0	27

*Parents of these strains were grown in greenhouse during the winter of 1927-28.

TABLE IV.—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES FROM A PROBABLE NATURAL CROSS BETWEEN PARTIALLY RESISTANT BIG CUBA AND SUSCEPTIBLE CONNECTICUT ROUND TIP TOBACCO PLANTS WHEN GROWN IN THE FIELD IN INFESTED SOIL—Continued.

Generation	Progeny No.	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
	R-27-12	271	94	0	6
	R-27-14	39	90	0	10
	R-27-16	92	89	6	5
	R-27-17	58	95	3	2
	R-27-19	154	72	5	23
	R-27-20	126	75	0	25
	R-27-23	137	90	1	9
	R-27-26	46	89	0	11
	R-27-28	78	67	0	33
	R-27-29	92	84	0	16
	R-27-31	138	92	1	7
	R-27-35	172	84	1	15
	R-27-38	74	77	3	20
	R-27-39	220	92	3	5
	R-27-40	279	82	10	8
	1929				
Commercial Stock	Conn. Round Tip (check)	96	0	4	96
Fifth	R-28-1	51	65	15	20
	R-28-2	65	83	9	8
	R-28-3	47	81	12	7
	R-28-4	82	70	21	9
	R-28-10	97	88	5	7
	R-28-12	254	94	0	6
	R-28-13	164	92	7	1
	R-28-14	55	95	3	2
	R-28-15	124	81	9	10
	1930				
Sixth	R-29- 1	135	61	7	32
	R-29-10	253	78	4	18
	R-29-11	262	72	7	21
	R-29-15	256	78	3	19

It may be observed from Table IV that certain selections of R were highly resistant to blackshank in 1928 and in 1929 and that these resistant selections were obtained in a shorter period of time than was required to obtain a resistant strain from the No. 1 cross discussed previously. The leaf characters are shown in Fig. 7 and the growth characters in infested soil are shown in Fig. 8. In many respects the leaves resemble Connecticut Round Tip, the main differences being that the leaf is broader at the "heel"; the lateral veins form a little more acute angle with the midrib and the leaf is a little broader in proportion to the length. This strain was tested on a small commercial scale in 1929 and 1930. The quality of leaf proved very good under slat and combination shade but was not so good under cloth alone.

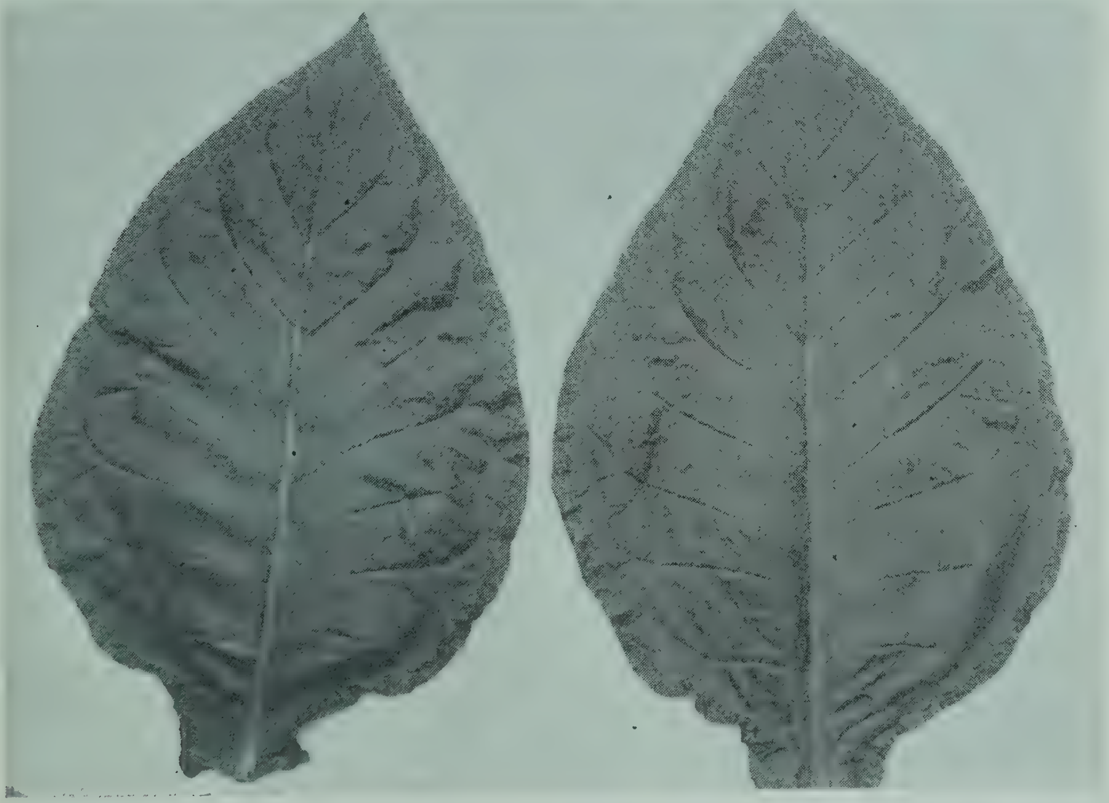

Fig. 7.—The fifth (left) and tenth leaves from a plant of the resistant strain R. Note that the leaves are broad in proportion to length and that the angle formed by the lateral veins and midrib is more acute than that of the Connecticut Round Tip variety.

The first crosses between Big Cuba and Little Cuba were made in 1924. The strain of Big Cuba used in the crosses was an F progeny of the selfed selection made in 1922, which was growing on infested soil. Only 48 percent of the plants of this strain remained healthy until the end of that season. The strain of Little

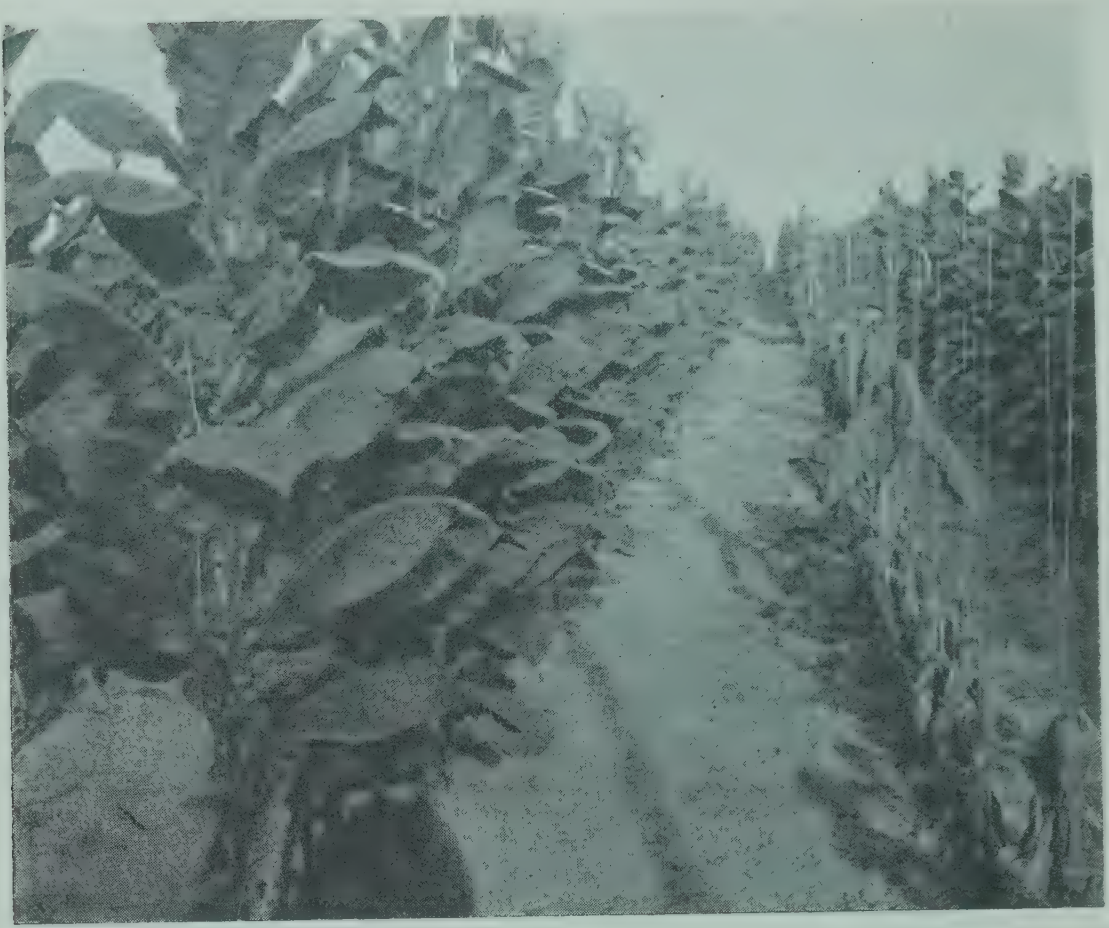

Fig. 8.—The resistant strain R (left) and susceptible Connecticut Round Tip (right) on Phytophthora-infested soil in 1929. Photographed after the first three or four leaves had been harvested.

Cuba used in the crosses had been self-pollinated and tested on infested soil for one year only, and at the end of the season 80 percent of the plants were living and 50 percent were healthy. The individuals of each strain used in the crosses were selected for vigor and desirable leaf characters. Reciprocal crosses were made between the two strains, different individuals being used for each cross. Four crosses were made, with Big Cuba as the female parent in two and Little Cuba in two. The hybrid seed of which Big Cuba was the female parent were given the numbers 301 and 303, and those in which Little Cuba was the female parent were numbered 302 and 304. The female parent of the 304 cross was dead by the time the seed were mature and the seed were discarded. The second and all subsequent generations through 1930 were tested successively in infested soil in the field and the results of the tests are shown in Table V.

TABLE V. — OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES FROM CROSSES BETWEEN THE PARTIALLY RESISTANT BIG CUBA AND LITTLE CUBA STRAINS OF TOBACCO WHEN GROWN IN THE FIELD IN INFESTED SOIL.

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
		1925			
Commercial Stock	Big Cuba (check)	200	1	3	96
Second	301- 1	196	42	13	45
	301- 2	200	61	18	21
	301- 4	197	65	13	22
	302- 1	202	41	20	39
	302- 2	190	37	12	51
	302- 3	196	48	17	35
	302- 4	210	22	3	75
	302-10	204	39	7	54
	303- 3	188	30	19	51
	303- 4	209	27	4	69
	303- 6	195	42	18	40
	303- 8	191	43	17	40
	303-10	210	42	5	53
	303-11	205	25	2	73
		1926			
Commercial Stock	Big Cuba (check)	225	2	4	94
Third	301-1-1	193	64	5	31
	301-2-1	203	70	6	24
	301-2-2	212	88	4	8
	301-4-1	98	81	4	15
	301-4-2	210	42	4	54
	301-4-4	200	56	11	33
	301-4-5	212	82	2	16
	302-1-1	200	88	5	7
	302-1-2	215	51	5	44
	302-2-1	207	36	10	54
	302-2-2	202	40	6	54
	302-2-4	208	58	5	37
	302-3-1	108	40	10	50
	302-3-2	97	64	4	32
	302-3-3	210	55	4	41
	303- 3-1	200	12	4	84
	303- 4-1	111	44	5	51
	303- 6-2	216	53	7	40
	303- 8-1	202	83	3	14
	303- 8-2	210	78	3	19
	303-10-1	131	74	12	14
	303-10-3	120	90	6	4
	303-10-5	133	58	13	29

TABLE V.—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES FROM CROSSES BETWEEN THE PARTIALLY RESISTANT BIG CUBA AND LITTLE CUBA STRAINS OF TOBACCO WHEN GROWN IN THE FIELD IN INFESTED SOIL. —Continued.

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
	1927				
Commercial Stock	Conn. Round Tip (check)	319	0	0	100
Fourth	301-2-2-1	226	74	9	17
	301-2-2-2	216	72	17	11
	301-4-1-2	198	60	14	26
	301-4-1-3	111	90	3	7
	301-4-1-4	298	70	11	19
	301-4-4-1	206	81	4	15
	301-4-4-3	116	86	9	5
	301-4-5-1	892	85	9	6
	301-4-5-2	699	85	6	9
	301-4-5-3	331	80	6	14
	301-4-5-4	450	75	9	16
	302-1-1-1	752	75	7	18
	302-1-1-2	548	76	7	17
	302-1-1-3	272	76	13	11
	302-1-1-4	560	68	7	25
	302-1-1-5	554	83	6	11
	302-1-1-6	543	78	10	12
	302-1-1-7	559	66	8	26
	302-2-2-1	173	64	20	16
	302-2-4-1	277	66	14	20
	302-2-4-2	281	58	22	20
	302-3-1-1	276	67	7	26
	302-3-3-1	169	83	3	14
	303-8-1-1	187	79	7	14
	303-8-1-4	217	79	8	13
	303-8-2-1	134	78	10	12
	303-8-2-5	166	75	4	21
	303-10-3-1	75	96	4	0
	303-10-3-5	158	93	0	7
	1928				
Commercial Stock	Conn. Round Tip (check)	858	0	0	100
Fifth	301-4-1-2-1	37	76	5	19
	301-4-1-4-1	73	85	0	15
	301-4-1-4-2	46	89	9	2
	301-4-5-1-1	434	92	1	7
	301-4-5-1-3	134	85	2	13
	301-4-5-1-4	82	97	1	2
	301-4-5-1-5	121	92	1	7
	301-4-5-1-7	135	93	2	5
	301-4-5-1-8	89	92	5	3

TABLE V.—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES FROM CROSSES BETWEEN THE PARTIALLY RESISTANT BIG CUBA AND LITTLE CUBA STRAINS OF TOBACCO WHEN GROWN IN THE FIELD IN INFESTED SOIL. —Continued.

Generation	Progeny No.	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
	301-4-5-1- 9	261	95	1	4
	301-4-5-1-10	342	90	7	3
	301-4-5-1-11	338	90	2	8
	301-4-5-1-12	273	93	2	5
	301-4-5-1-13	203	91	3	6
	301-4-5-2-2	204	87	3	10
	301-4-5-2-3	209	90	0	10
	301-4-5-2-4	147	92	2	6
	301-4-5-3-1	97	100	0	0
	301-4-5-3-2	89	95	1	4
	301-4-5-3-3	128	92	3	5
	301-4-5-3-4	250	98	1	1
	301-4-5-3-6	118	89	3	8
	301-4-5-3-7	244	95	0	5
	301-4-5-3-8	317	91	3	6
	301-4-5-4-3	210	85	3	12
	301-4-5-10-2	254	86	0	14
	301-4-5-10-3	143	96	1	3
	302-1-1-6-1	47	96	4	0
	302-1-1-6-2	60	95	2	3
	303-8-1-4-1	44	95	5	0
	303-10-3-1-1	85	100	0	0
	1929				
Commercial Stock	Conn. Round Tip (check)	369	0	2	98
Sixth	301-4-5-1-1-1	365	89	6	5
	301-4-5-1-1-3	99	89	4	7
	301-4-5-1-1-4	93	95	2	3
	301-4-5-1-1-6	116	94	2	4
	301-4-5-1-4-1	52	88	4	8
	301-4-5-1-7-2	261	95	1	4
	301-4-5-1-7-3	119	92	4	4
	301-4-5-1-7-4	149	88	5	7
	301-4-5-1-8-2	131	75	17	8
	301-4-5-1-9-1	131	89	4	7
	301-4-5-1-9-3	62	97	3	0
	301-4-5-1-10-4	68	100	0	0
	301-4-5-1-11-1	264	92	2	6
	301-4-5-1-11-2	259	95	1	4
	301-4-5-1-11-3	262	94	0	6
	301-4-5-1-11-4	132	92	2	6
	301-4-5-1-12-2	142	94	2	4
	301-4-5-1-13-1	96	87	5	8

TABLE V.—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES FROM CROSSES BETWEEN THE PARTIALLY RESISTANT BIG CUBA AND LITTLE CUBA STRAINS OF TOBACCO WHEN GROWN IN THE FIELD IN INFESTED SOIL.—Continued.

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
	301-4-5-1-13-3	63	98	0	2
	301-4-5-1-S-1	255	97	1	2
	301-4-5-1-S-2	135	98	1	1
	301-4-5-3-7-1	96	94	1	5
	301-4-5-3-7-2	113	93	1	6
	301-4-5-3-7-3	268	94	3	3
	301-4-5-3-7-4	71	93	4	3
	301-4-5-10-3-1	81	95	1	4
	301-4-5-10-3-2	28	82	7	11
	1930				
Commercial Stock	Conn. Round Tip (check)	333	0	1	99
Seventh	301-4-5-1-S-1-1	51	90	2	8
	301-4-5-1-S-2-1	46	85	4	11
	301-4-5-1-1-1-1	54	89	0	11
	301-4-5-1-1-1-3	48	79	2	19
	301-4-5-1-1-1-4	47	83	2	15
	301-4-5-1-1-6-1	50	64	4	32
	301-4-5-1-7-2-1	256	92	2	6
	301-4-5-1-7-2-3	256	84	5	11
	301-4-5-1-7-2-4	262	87	3	10
	301-4-5-1-7-2-6	193	91	1	8
	301-4-5-1-7-2-7	103	86	2	12
	301-4-5-1-7-3-1	96	86	0	14
	301-4-5-1-10-3-1	52	85	5	10
	301-4-5-1-10-3-2	99	80	0	20
	301-4-5-1-11-2-1	100	79	4	17
	301-4-5-1-11-2-4	49	84	4	12
	301-4-5-1-11-3-2	101	82	1	17
	301-4-5-1-11-3-3	99	83	1	16
	301-4-5-1-11-3-4	206	92	1	7
	301-4-5-1-11-4-1	46	78	0	22
	301-4-5-3-7-3-1	195	65	4	31
	301-4-5-3-7-3-2	199	85	3	12
	301-4-5-3-7-3-3	94	93	1	6
	301-4-5-3-7-3-4	102	87	2	11
	301-4-5-10-3-2-2	48	81	4	15
	303-10-3-1-1-1	64	80	6	14
	303-10-3-1-1-3	66	79	9	12
	303-10-3-1-1-4	66	91	9	0
	303-10-3-1-1-5	67	95	3	2
	303-10-3-1-1-6	68	81	10	9

As may be seen from Table V, the F_2 progenies of the crosses between partially resistant strains of Big Cuba and Little Cuba showed relatively low resistance. However, with continued selection and self-pollination through the F_5, a highly resistant strain was developed. Each year after 1926 certain selections were dropped from the tests because of low resistance or undesirable leaf characters, or both. After 1928 all selections originating from the 302 cross were discontinued because of undesirable quality. The quality of the selections of 303 varied with the season, being fair in certain seasons, and poor in other seasons. The leaves of this strain are relatively broad in proportion to the length and the lateral veins form a desirable angle with the midrib. The average number of leaves per plant is low but, on account of the large size of leaf, the yield would perhaps be such that it could be grown profitably.

It will be observed that all strains of the 301 cross which have been continued throughout the tests originated from the same F_3 individual. Certain selections of this strain have been eliminated because of undesirable leaf characters, low leaf number, or lack of resistance, until the important characters of all selec-

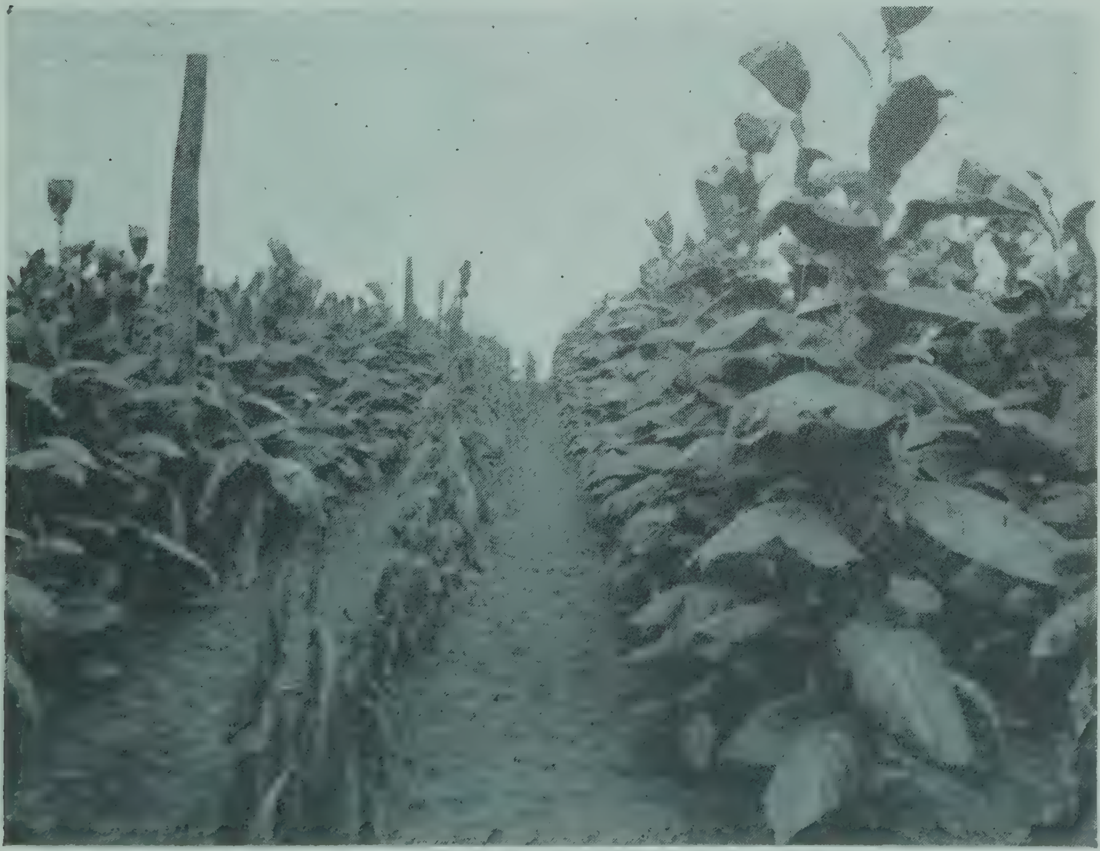

Fig. 9.—Selections of the resistant strain 301 (left and right) and Connecticut Round Tip (center) in Phytophthora-infested soil in 1929.

tions are more or less similar. Certain selections average one or two more leaves per plant than others and there is usually a slight difference in the shade of color of the green leaves. There is also a slight difference in the angle which the leaves form with the stalk. Furthermore, as may be observed in Table V, there was still some difference in degree of resistance as between selections in 1930.

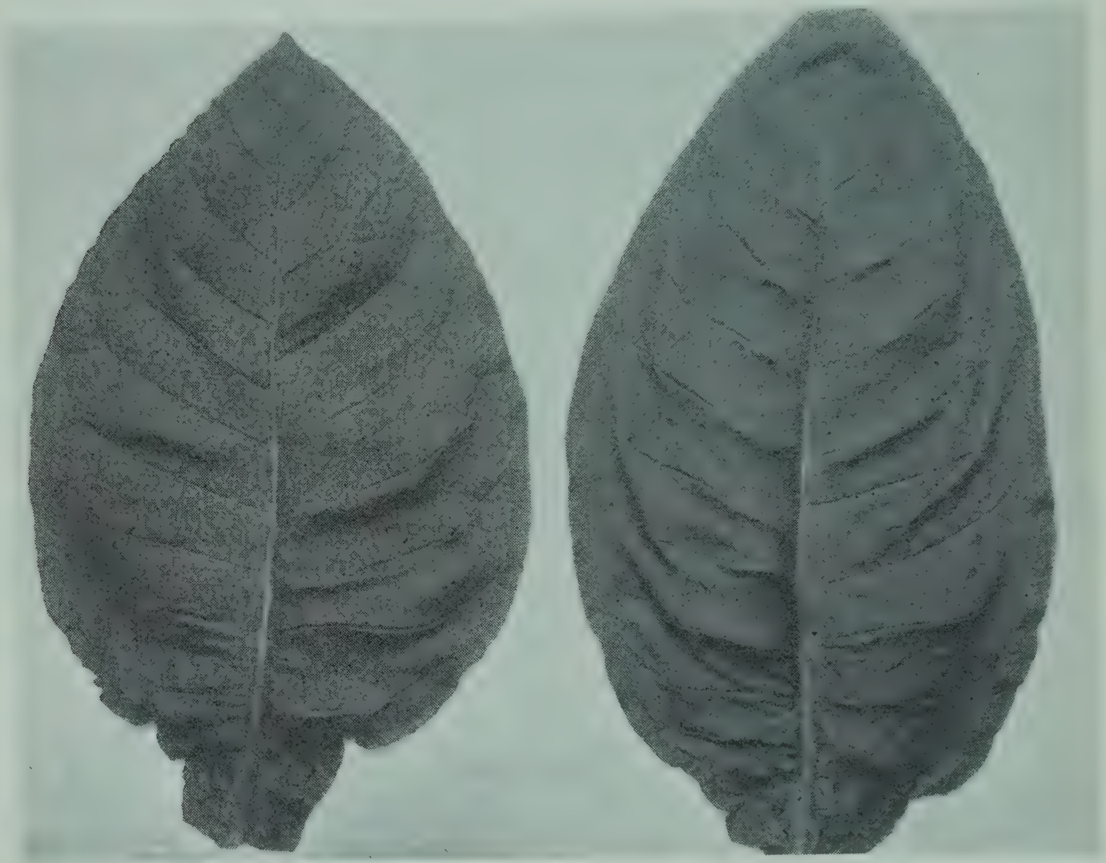

Fig. 10.—The fifth (left) and tenth leaves from a plant of the resistant strain 301. The angle formed by the lateral veins and midrib is about the same as that of Little Cuba, the male parent.

Certain strains of 301 have been tested for two years on an extensive commercial scale and in most cases the yield, quality, and resistance in infested soil have been very satisfactory. Although the weather conditions were not conducive to the production of a good quality during the period of these tests, most packers reported that the quality of 301 was as good as or better than most crops of Connecticut Round Tip grown on new land. Furthermore, the manufacturers have not discriminated against it because it is a new strain of the cigar wrapper type. It suffices to say, therefore, that 301 can be grown profitably in Phytophthora-infested soil under Florida conditions.

The quality of 301 has averaged very good for three years in a series of fertilizer experiments on two acres of shade on the Tobacco Station farm. Results of these tests will not be presented here, as they will be published after that experiment has been concluded.

The seedlings of 301 reached the stage for transplanting several days earlier than either of the parents or Connecticut Round Tip. It matures in the field about seven to ten days later than Little Cuba but is earlier than Big Cuba or Connecticut Round Tip. There are certain minor objections to the 301 strain which apparently may not be overcome by further selection. Chief among these are the drooping habit of the leaves on the stalk (Fig. 9) and a tendency for the leaves to turn or fold over on the midrib during windstorms. The leaves are relatively large (Fig. 10) and because of their tendency to droop it is difficult to prime the lowest leaves without breaking the tips of some of the ones immediately above. If the leaves turn on the midrib their quality will be impaired unless they are turned back to their natural position within 24 hours. This objection is overcome largely by growing the crop under cloth or combination shade with walls.

94

In 1926 a cross was made between selections of 301 and R and assigned the number 94. In this cross the 301 plant was the male parent and R the female. The parent plants were selected for general vigor and desirable leaf characters. The reciprocal cross was made using different individuals. The seed of this cross were discarded because the root system of the female parent was badly diseased when it was harvested. Ten other crosses were made that year using selections of 301 in part of them and other resistant strains in the remainder. The F_2 progenies from the 11 crosses were tested in the field in infested soil in 1927. Most of these F_2 and subsequent progenies showed a high degree of resistance to blackshank but only three of them produced leaves of suitable quality for cigar wrappers. In this respect the progenies of strain number 94 were outstanding and only the results of tests with that strain will be considered in this paper. Tests with selections of the other two strains will be continued and reported upon later, if they should prove to be of any commercial value. Results of the trials with the strain 94 from 1927 to 1930, inclusive, are shown in Table VI.

It will be observed from Table VI that the F_2, F_3, and F_4 progenies of 94 showed high resistance to blackshank. Although several of the F_5 selections showed high resistance in 1930, many of them showed more susceptible plants than any previous generation. This segregation into susceptible and resistant plants in the F_5 was more marked than was observed with any other strain resulting from a cross.

TABLE VI.—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES FROM A CROSS BETWEEN RESISTANT 301 AND RESISTANT R TOBACCO PLANTS WHEN GROWN IN THE FIELD IN INFESTED SOIL.

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
		1927			
Commercial Stock	Conn. Round Tip (check)	286	0	2	98
Second	94-1	112	74	9	17
	94-2	74	73	16	11
		1928			
Commercial Stock	Conn. Round Tip (check)	450	0	0	100
Third	94-1-1	125	72	0	28
	94-1-4	373	91	2	7
	94-1-7	224	92	2	6
	94-1-17	500	90	1	9
	94-2-1	89	100	0	0
	94-2-2	174	99	0	1
	94-2-4	108	87	2	11
	94-2-5	367	88	4	8
	94-2-7	305	93	1	6
		1929			
Commercial Stock	Conn. Round Tip (check)	273	0	0	100
Fourth	94-1-1-1	59	92	3	5
	94-1-1-2	40	90	0	10
	94-1-4-1	54	96	4	0
	94-1-7-1	42	90	5	5
	94-1-17-1	117	84	9	7
	94-1-17-4	60	97	1	2
	94-2-1-1	71	87	9	4
	94-2-1-3	67	93	0	7
	94-2-2-1	66	91	7	2
	94-2-2-2	25	92	4	4
	94-2-5-1	70	60	7	33
	94-2-5-2	56	96	2	2

TABLE VI.—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES FROM A CROSS BETWEEN RESISTANT 301 AND RESISTANT R TOBACCO PLANTS WHEN GROWN IN THE FIELD IN INFESTED SOIL—Continued.

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
	94-2-5-3	72	96	0	4
	94-2-5-5	63	97	1	2
	94-2-7-1	82	74	20	6
	94-2-7-2	256	95	3	2
	94-2-7-4	257	93	2	5
	94-2-7-5	264	77	12	11
	94-2-7-6	124	76	8	16
	94-2-7-7	252	87	9	4
	94-2-7-8	259	89	5	6
	1930				
Commercial Stock	Conn. Round Tip (check)	333	0	1	99
Fifth	94-1-1-2-1	52	94	0	6
	94-1-4-1-1	51	88	0	12
	94-1-17-1-1	50	72	2	26
	94-1-17-1-3	48	96	0	4
	94-1-17-1-4	44	93	0	7
	94-1-17-4-2	49	74	10	16
	94-1-17-4-3	50	68	2	30
	94-1-17-4-4	45	84	3	13
	94-2-1-1-1	45	91	0	9
	94-2-1-1-2	52	96	2	2
	94-2-1-3-1	47	91	0	9
	94-2-2-1-1	64	88	1	11
	94-2-2-2-1	62	77	2	21
	94-2-2-2-2	70	79	1	20
	94-2-5-2-1	44	82	0	18
	94-2-5-2-2	46	65	0	35
	94-2-5-2-3	50	40	0	60
	94-2-5-2-4	55	42	2	56
	94-2-5-3-1	48	75	2	23
	94-2-5-3-2	47	89	5	6
	94-2-5-3-3	74	68	2	30
	94-2-5-5-1	75	75	4	21
	94-2-5-5-2	56	64	2	34
	94-2-5-5-3	50	70	0	30
	94-2-5-5-4	53	64	6	30
	94-2-5-5-5	49	55	4	41
	94-2-7-2-1	255	64	16	20
	94-2-7-2-2	630	63	6	31
	94-2-7-2-3	253	71	14	15
	94-2-7-2-4	258	35	36	29

TABLE VI.—OCCURRENCE OF BLACKSHANK IN SELFED PROGENIES FROM A CROSS BETWEEN RESISTANT 301 AND RESISTANT R TOBACCO PLANTS WHEN GROWN IN THE FIELD IN INFESTED SOIL—Continued.

Generation	Progeny Number	No. of Plants Tested	Condition at End of Season		
			Healthy	Diseased	
			Percent	Living Percent	Dead Percent
	94-2-7-2-5	262	59	15	26
	94-2-7-2-6	254	54	14	32
	94-2-7-2-7	277	73	15	12
	94-2-7-2-8	255	57	14	29
	94-2-7-2-9	255	61	6	33
	94-2-7-2-10	261	82	7	11
	94-2-7-4-1	246	79	2	19
	94-2-7-4-2	264	80	8	12
	94-2-7-4-3	256	80	5	15
	94-2-7-4-4	247	83	5	12
	94-2-7-4-5	262	57	17	26
	94-2-7-4-6	267	74	12	14
	94-2-7-4-8	260	65	18	17
	94-2-7-4-9	258	82	6	12
	94-2-7-5-1	130	79	3	18
	94-2-7-5-2	127	57	8	35
	94-2-7-5-3	141	75	2	23
	94-2-7-7-1	131	75	4	21
	94-2-7-7-3	129	84	4	12
	94-2-7-8-1	130	82	3	15
	94-2-7-8-2	119	71	25	4
	94 (stock)*	127	74	7	19

*This seed was a composite sample taken from a stock lot saved in 1929 from a commercial test by a grower.

There were noticeable differences in leaf characters among plants of the F_2 selections and between sister selections in the F_3. However, the selections 94-2-5 and 94-2-7 appeared very uniform in all important morphological characters. The selection 94-2-7 possessed very desirable qualities for cigar wrapper, both in size and shape of leaf and color and weight of the cured product. Because of these desirable characters, a small acreage of this selection was grown on a commercial basis in 1929. Results of this trial, together with those of the test plots, aroused a great deal of interest among the growers. The acreage of commercial trials was increased in 1930 and as a whole the yield and quality were satisfactory. In some cases the crop suffered severely from drought and in such cases a higher percentage of blackshank developed. The leaves of this strain possess characters favored by cigar manufacturers.

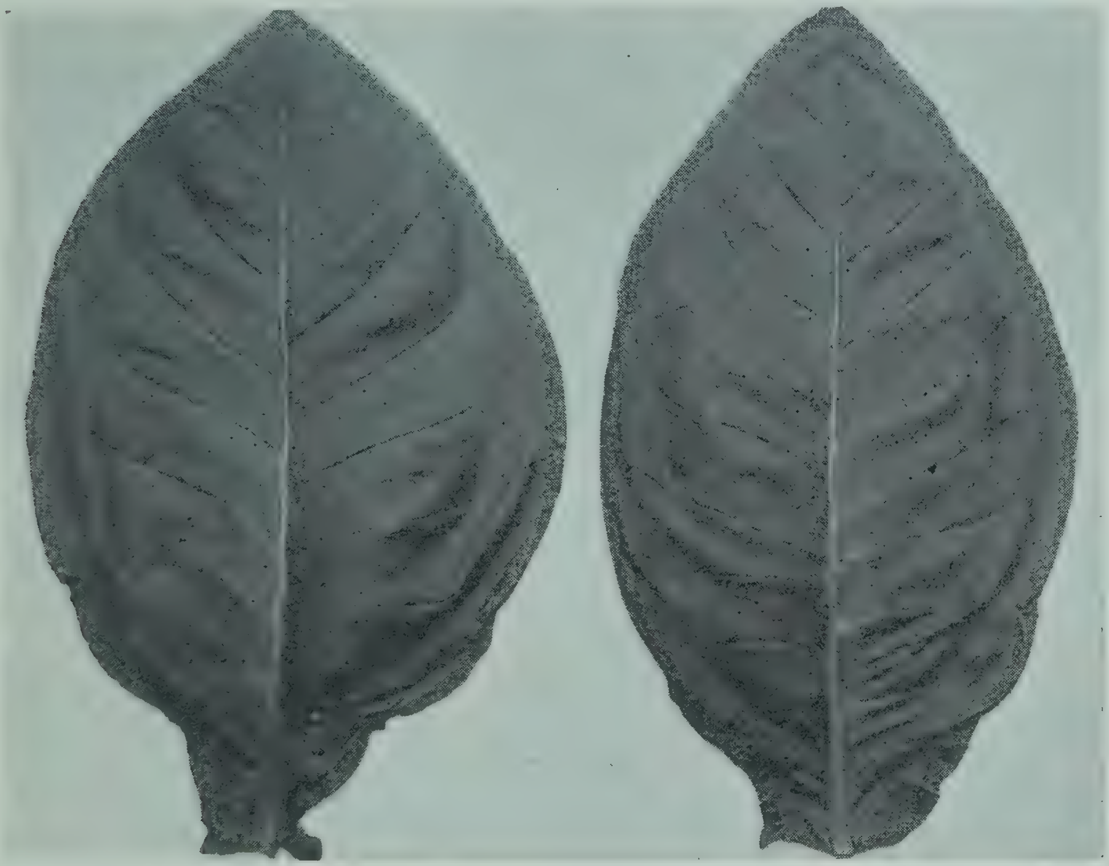

Fig. 11.—The fifth (left) and tenth leaves from a plant of the resistant strain 94. The angle formed by the lateral veins and midrib is about the same as that of Connecticut Round Tip.

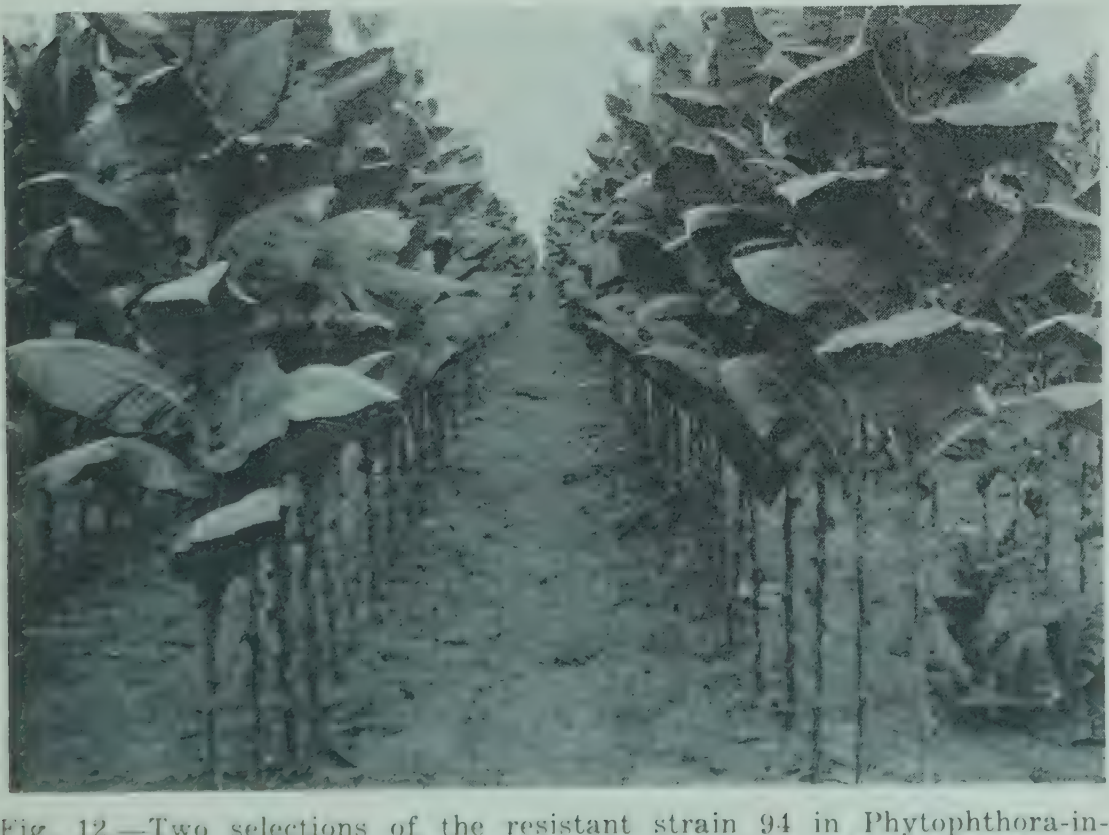

Fig. 12.—Two selections of the resistant strain 94 in Phytophthora-infested soil in 1929. Photographed after about one-third of the leaves had been harvested.

The lateral veins of the 94 strain form an angle with the midrib (Fig. 11), which is desirable for successful stripping by machinery. Other characters of the cured leaf which constitute quality, as firmness, elasticity, and fineness of texture, are considered excellent. Also, the yield and characters of growth in the field have been satisfactory. The strain has not been tested long enough to be sure that the type is fixed in any of the selections, but it seems to possess the most desirable characters for cigar wrappers of any new strain. The seedlings reach the stage for transplanting and mature in the field several days earlier than the Big Cuba or Connecticut Round Tip. Growth characters of two of the sister strains growing in infested soil in 1929 are shown in Fig. 12.

OTHER CROSSES

During the last four years 36 other crosses have been made. Most of these were between resistant strains which possessed certain qualities desired in cigar wrappers. Although the progenies of several of the crosses show indications of desirable combinations for the improvement in quality of leaf and resistance to blackshank, the trials have not been continued long enough to warrant a detailed report here.

DISCUSSION

The evidence obtained in connection with these studies leads to the conclusion that of the numerous commercial varieties of tobacco tested only a few show any resistance to the attack of *Phytophthora nicotianae* Breda de Haan. Only a very small percent of the plants of most of these few varieties resist the parasite under favorable conditions for development of the disease. Such plants were usually heterozygous for resistance and their progenies showed no uniformity in the segregation of resistant and susceptible individuals. The first generation of some of the plants showed high resistance, while others showed various degrees of resistance. Highly resistant strains were isolated by continuing to select the most resistant plants for several years but the increase in degree of resistance from year to year was gradual in most cases. Strains completely free of susceptible plants under field conditions in the Florida-Georgia district have not been obtained.

The commercial varieties known as Dubek (Russia) and Havanensis (a Cuban wrapper type) were the exceptions in that they showed a high degree of resistance to blackshank. However, continued selection of the resistant plants has not resulted in completely resistant strains of these varieties when grown under field conditions.

The information obtained does not explain satisfactorily the failure to obtain strains of tobacco completely free from susceptible plants. It also fails to explain why so many years selecting and selfing were required to isolate highly resistant strains from certain varieties and crosses. However, the results indicate that the resistant character is not governed by a simple genetic factor and that resistance is a relative condition, since it is affected by the environment. Assuming that the initial selected plants were heterozygous for the resistant character, it should be possible by selecting and selfing the best plants to eliminate the undesirable susceptible character in the second or third generation. This should be expected particularly with diseases such as blackshank of tobacco in which the causal parasite survives in the soil from year to year under environmental conditions which are favorable for development of the disease during a greater part of the growing season. It appears rather improbable that the plants selected for seed in the trial plots had escaped contact with the parasite, since the susceptible varieties used in the check rows almost invariably showed 100 percent infection. Since, during the last three years, certain selections were made in an effort to maintain particular leaf characters, it is possible that in such cases the plants were selected each year from the group which was heterozygous for the resistant character. However, during the first three years of the work plants were selected from the Big Cuba variety for resistance regardless of leaf characters. Even so, five years were required to develop a highly resistant strain of that variety.

Data obtained over a period of three years have indicated that injury caused by the root-knot nema (*Heterodera radicicola* (Greef) Mueller) may affect the degree of resistance. In several instances the trial plot in commercial fields proved to be heavily infested with this nema. In all such cases the same strains of tobacco showed a lower degree of resistance than in fields with slight nema infestation. The plants which succumbed to blackshank late in the season usually showed severe nema injury, while the ones which remained free from blackshank in the same field usually showed slight injury from this cause.

Cultural methods also appear to affect resistance. In all the trials in commercial fields the plants were grown under cultural practices followed by the farmer. In several instances the farmer cultivated deep until late in the season. Under such conditions the resistant strains showed less resistance to blackshank than in fields where shallow cultivation was used. This was especially noticeable in years when there was light rainfall during the growing season. Such cultural methods materially retard the growth of the crop, even on uninfested soil, and it appears probable that an injurious effect would also be exerted on the resistant character.

High temperature also may affect the degree of resistance. The optimal temperature for growth of *Phytophthora nicotianae* in culture is from 25° to 30°C., but the optimal temperature for the growth of cigar wrapper tobacco has not been determined. The temperature under the shades reaches a maximum of 35°-40°C. for several hours of the day during the latter part of the season. Oftentimes this high temperature is accompanied by light rainfall. Under such conditions the growth of tobacco plants was greatly checked. Thus, it appears probable that the high temperatures which obtain under field conditions at certain periods of the year may weaken the resistant character. It is planned to study in the future the effect of these environmental factors on the resistant character.

No evidence has been accumulated in these investigations which shows that resistance to blackshank is linked with important type characters of tobacco or with resistance to other diseases. Resistant strains have been obtained from several commercial varieties which represent as many leaf types. Furthermore, among the numerous varieties tested for resistance to blackshank, Connecticut Round Tip, Halladay Havana, and Xanthia (Turkish) have been reported to be resistant to Thielavia root rot.[11] All of these varieties proved 100 percent susceptible to blackshank. Furthermore, a strain of Big Cuba resistant to root rot which was developed in Florida was completely susceptible to blackshank.

The resistant strain of Big Cuba differs from the commercial variety in having a slightly darker green color of leaves with undulate or ruffled margins. The apparent reason for these deviations is that the disease reduced the plants available for the original selections to a very small group and there was little opportunity to select for the predominant type of the commercial variety. The quality of the cured leaf of this resistant strain and of the commercial variety is about the same when the plants are grown under similar conditions.

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[11] Johnson, James. Breeding tobacco for resistance to Thielavia root rot. U.S.D.A. Tech. Bul. 175:1-20. 1930.

Yield and "demands of the trade" are the principal factors to be considered in connection with the introduction into commerce of these resistant strains. On account of the high cost of producing tobacco under artificial shade in Florida and of the fluctuation in price of the cured leaf from year to year, with a rather definite upper limit, it has been estimated that a variety which yields less than 1,000 pounds per acre is unprofitable. Therefore, since *Phytophthora nicotianae* has become so generally distributed in the Florida-Georgia district, it is impractical to attempt to grow the standard susceptible variety, except on a limited scale in certain localities. During 1929 and 1930 the blackshank resistant strains 301 and 94 were substituted in an increasing percentage for the susceptible Connecticut Round Tip and they produced a profitable yield on infested soil.

The demand for light colored, thin, mild, and free-burning tobacco comes clearly from the manufacturer and consumer who have used large quantities of Florida-grown wrappers for years. Consequently, it would be quite unprofitable to grow a large yield of any quality of leaf which does not meet these demands, as both of these factors determine whether the crop can be grown at a profit. Fortunately, the new strains 301 and 94 have been accepted favorably by the trade and since the yield was satisfactory the growers were enabled to continue operations. With a few more years' experience in growing and packing these strains, it appears probable that a higher yield per acre of the best grades will be produced on infested soil than was formerly obtained with the standard susceptible varieties before blackshank occurred in the district.

SUMMARY

The nature of the disease, and the method of hybridization and testing progenies of tobacco in the field for resistance to blackshank, are described.

The P strain is a resistant selection from Big Cuba, a commercial variety of cigar wrapper tobacco which was grown under shade almost exclusively from 1909 to 1922. After selecting and selfing for six years, a strain was obtained which showed a high degree of resistance to blackshank in thoroughly infested soil. This resistant strain resembles the parent variety in its main features and quality of leaf, although under certain conditions the cured leaf is slightly more sleazy.

In like manner resistant strains have been developed from the Little Cuba (Cuba), Dubek (Russia), and Santiago (Java) varieties.

The quality of Little Cuba is considered very good but it cannot be grown profitably under shade in Florida because of the low yield. Dubek and Santiago are not cigar wrapper varieties and the yield is low. The resistant strains of these three varieties closely resemble the parent varieties in all the main characters that were compared.

Number 1 is a new resistant strain resulting from a cross between a partially resistant strain of Big Cuba and susceptible Connecticut Round Tip. After selecting and selfing for six generations from the cross, progenies were obtained which showed a high degree of resistance under conditions favorable for development of the disease. The leaves of this strain are larger than those of either parent but in the main characters they resemble Big Cuba more than Connecticut Round Tip. The main characters appear to be fixed, although the strain is not completely resistant when grown in the field. The color of the cured leaf is good, but it is fairly coarse and has a bitter taste.

R is a new resistant strain resulting from a suspected cross between a resistant strain of Big Cuba and susceptible Connecticut Round Tip. After selecting and selfing for five generations, progenies were obtained which showed great uniformity in growth characters and were highly resistant to blackshank. The shape, size, and quality of leaf are similar in the main features to Connecticut Round Tip. This variety has not been tested extensively under slat shade but it appears to have possibilities for a good wrapper tobacco.

Number 301 is a new strain resulting from a cross between resistant Big Cuba and resistant Little Cuba. After selecting and selfing for six generations, progenies were obtained which were uniform for the important growth characters and resistance to blackshank. The leaf characters represent a blend of those of both parents. The maturity is intermediate. The seedlings reach the stage for transplanting from seven to ten days earlier than Big Cuba and Connecticut Round Tip. This strain has been tested two years on an extensive commercial scale and in most cases the quality proved to be very good. Undesirable characters of this strain are manifest in the drooping position of the leaves on the stalk and turning of the leaves on the midrib.

Number 94 is a new strain resulting from a cross between 301 and R. After selecting and selfing for four generations, progenies were obtained which showed uniformly high resistance to blackshank in thoroughly infested soil. Tests have not been continued a sufficient number of years to be sure the type is fixed, although some of the selections appear uniform for leaf characters. The shape and size of the leaf of this strain are somewhat similar to Connecticut Round Tip and the yield will probably be as great under most conditions. It is about the same as 301 in earliness of seedlings and maturity of leaf. So far, the quality of cured leaf has been superior to that of any other variety tested. Further selections are being made from the best progenies and they will be multiplied for trial on a commercial scale as soon as the trials justify releasing them.

Three of the resistant strains have been released for commercial growing. These are P, 301, and 94. However, there is little demand for the P strain because of certain undesirable morphological characters and inferior quality. The quality of both 301 and 94 is very good but 94 has fewer objectionable growth characters.

Bulletin 230 June, 1931

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UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
Wilmon Newell, Director

SPRAYING AND DUSTING CUCUMBERS FOR CONTROL OF DOWNY MILDEW FROM 1925 TO 1930

By George F. Weber

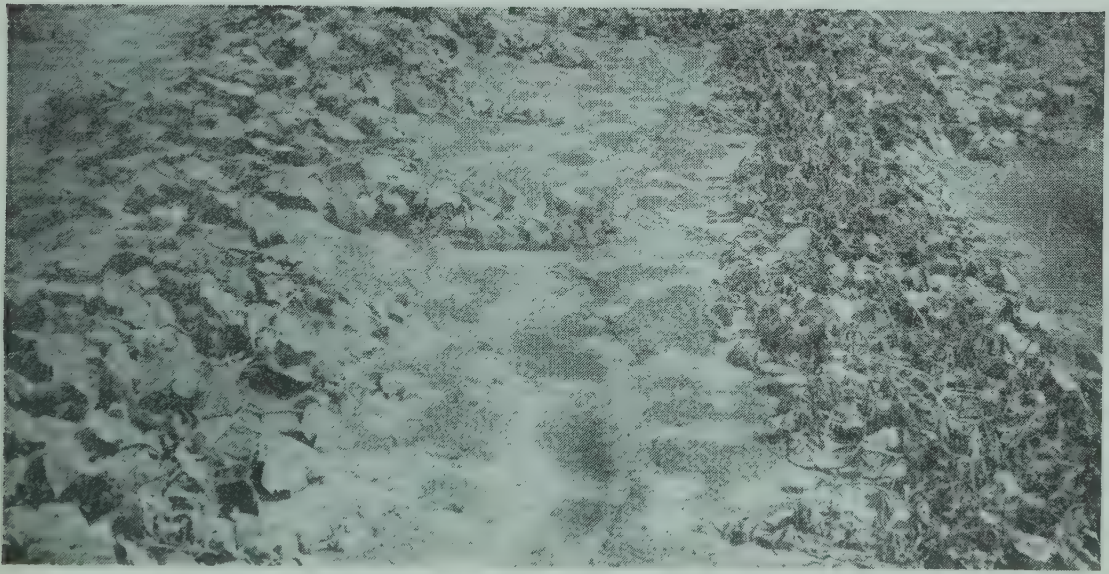

Fig. 1.—Portion of experimental plot showing sprayed plants on left and unsprayed (check) plants on right.

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SPRAYING AND DUSTING CUCUMBERS FOR CONTROL OF DOWNY MILDEW FROM 1925 TO 1930

By George F. Weber

INTRODUCTION

The Florida cucumber growers' yields are reduced annually by the premature destruction of the foliage of the vines by the common disease known as downy mildew (blight or rust) which is caused by the parasitic fungus *Peronoplasmopara cubensis* (B. & C.) Clint. *(12)*.[1] The disease as it occurs in Florida has been fully described *(84)* *(85)* and a repetition of the description in this connection is unnecessary. Control measures, as used by growers who have a limited period for marketing their crop of fresh cucumbers, have proved more or less unsatisfactory. During some seasons the duration of the period in which cucumbers can be marketed profitably is only two or three weeks and since downy mildew does not become very prevalent until about the beginning of the picking season, many growers contend that spraying or dusting is an unprofitable investment. Consequently, there has been great need for experimental information on the possibilities for increasing the yield of cucumbers by the use of fungicides under these conditions. Accordingly, spraying and dusting experiments were begun in 1925 and continued each year through 1930. This bulletin gives a review of the literature concerning control of this disease and a report of the results of the experiments conducted in Florida over the six-year period.

THE DISEASE

GEOGRAPHICAL DISTRIBUTION

According to Clinton *(12)*, the fungus which causes downy mildew of cucumbers was first collected in Cuba by Wright and described by Berkley and Curtis in 1869. Farlow *(19)* recognized it on specimens received from Japan in 1889. In the same year Halsted *(28)* reported it from New Jersey, which was the first report from the United States. Galloway *(22)* reported it from Florida and Texas during the same year. In 1890, Humphrey *(37)* reported it from Massachusetts and Swingle *(81)* reported it from Maryland. Since that time it has been reported from Connecticut *(3) (82)*, Rhode Island *(73)*, New Hampshire *(43)*, Vermont *(54)*, Maine *(10)*, New York *(54)*, Pennsylvania *(55)*, New Jersey *(28) (29) (30) (31) (49)*, Delaware *(48)*, West Virginia *(67)*, Virginia *(24)*, Kentucky *(23)*, Tennessee *(10)*, Ohio *(62) (65)*, Illinois *(60)*, Michigan *(55)*, North Carolina *(86)*, Wisconsin *(15)*, South Carolina *(46)*, Georgia *(34)*, Florida *(5) (36) (68) (85)*, California *(51)*, Alabama, Mississippi, Louisiana, Indiana, Texas, Colorado, and Arizona *(83)*. Chupp *(10)* lists all the states east of the Mississippi River and nine states west of it. In Florida the disease is more or less perpetual, having occurred in some sections every year since its discovery in 1889 with the possible exception of 1893 when Rolfs *(58)* reports that cucumbers grew from February to July and showed no disease. Hume *(35) (36)*, Fawcett *(20)*, Sherbakoff *(69)*, Burger *(6) (7)*, and Weber *(84) (85)* have reported the disease as occurring at practically all seasons of the year when cucumbers are grown during the past 30 years. Outside of the United States the disease has been reported from the following foreign countries: Bermuda *(52)*, Porto Rico *(83)*, Cuba *(13)*, Guam *(27)*, Colombia *(9)*, Ecuador *(8)*, Brazil *(1)*, Japan *(42)*, Russia *(59)*, Germany *(16) (18) (87)*, Austria *(33) (41)*, Hungary *(44)*, England, Italy, Australia, Java, China, New Zealand *(39)*, East Africa and India *(8)*. These reports show a world-wide distribution of the disease outside the United States and a distribution in this country in all but the arid mountainous states.

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[1] Figures in parentheses (italic) refer to Literature Cited in the back of this bulletin.

HOST RANGE

The disease was first reported on an undetermined cucurbit species. The other early reports *(19) (22) (28) (50) (62) (75) (81) (82)* show that the disease has appeared annually on cucumbers. At first it was most serious on greenhouse plants but gradually involved cucumbers in the field. Later Halsted *(31)* found it on watermelon and considered it responsible for failures of this crop. He also reported it on squash and pumpkin. Cantaloupes are recorded as having suffered in the North Atlantic and New England states probably as much as or more than cucumbers *(2) (32) (57) (78)*. Gourds and certain ornamentals are susceptible, according to Butler *(8)*, Eriksson *(18)*, and Linhard *(44)*. Selby *(64)* planted a variety plot containing a large list of cucurbits and closely related plants for the purpose of determining the host range of this fungus. He found that the following plants were susceptible:

Bryonopsis laciniosa erythiocarpa Naud.
Citrullus vulgaris Schr.
Cocinnia indica W. & A.
Cucumis anguria L.
Cucumis erinaceus Hort.
Cucumis melo L.
Cucumis odoratissimus Moench.
Cucumis sativus L.
Cucurbita melopepo L.
Cucurbita moschata Duch.
Cucurbita pepo L.
Cucurbita verrucosa L.
Echinocystic lobata T. & G.
Lagenaria vulgaris Ser.
Melothria scabra Naud.
Momordica balsamia L.
Momordica charantia L.
Mukia scabrella Arn.
Sicyos angulatus L.
Trichasanthes colubrina Jacq.

In Florida the following cultivated hosts, including numerous varieties of each, have been found affected by the disease:

Citrullus vulgaris Schr.
Cucumis anguria L.
Cucumis melo L.
Cucumis sativus L.
Cucurbita maxima Duch.
Cucurbita moschata Duch.
Cucurbita pepo L.
Lagenaria leucantha Rusb.

The possibility of a wild host in Florida which harbors the disease during certain periods of the year has not been thoroughly investigated.

ECONOMIC IMPORTANCE

Downy mildew was not an economic factor in the United States until 1889, though it had been of mycological interest for the previous 20 years. Since the disease first came under observation, numerous reports have shown that its economic importance varies in different states and countries and in the same locality from year to year. It caused the first injury to greenhouse cucumbers in New Jersey according to Halsted *(28)*, and after a careful study he predicted it would be a destructive disease in the future. Later it was found that the disease spread to cucumbers in the field *(31)* after ruining the greenhouse crops *(30)* and was the probable cause of a watermelon failure in Massachusetts *(31)*. Halsted also noted *(32)* that it was erratic in its occurrence; for instance, it was common and destructive in 1897 and was not found in 1898. Burger *(6)* stated that it was the cause of short picking seasons in Florida, while Gilbert *(25)* reported that no serious damage was caused by it in Indiana. Manns and Adams *(47)* recorded a 40 percent loss in sections of Delaware in 1924. Bennett *(2)* in Connecticut reported that cucumber growers were driven from that state by the severity of this disease. Stone and Smith *(77) (78)* considered it common and of general occurrence under glass in Massachusetts. Selby *(65)* classified this disease as the most serious enemy of the cucumber and stated *(66)* that epidemics were caused by favorable weather conditions. Linhart *(44)* reported losses of 80 percent of all cucurbits in certain sections of Hungary. Stewart *(71)* *(72)* reported a 55 percent loss to cucumbers in certain sections of New York and stated that it was destructive on Long Island. Other reports in 1924 *(83)* include losses as follows: Delaware 2 percent, Maryland 1 percent, South Carolina 30 percent, Florida 30 percent, which are only a sample of reports each year during the past 10 years. In Florida, Hume *(35)* reported the first losses on cucumbers in 1889. Burger *(5)* stated that considerable loss was caused in 1913-14. Sherbakoff *(68)* considered cucumbers badly affected in 1915-17. During the past 10 years this disease has caused annually from 10 to 70 percent losses in this State. A very conservative estimate would be 15 percent loss annually. The annual farm value of cucumbers shipped from Florida over this 10-year period averages approximately two and a quarter millions of dollars. Thus the loss would amount to $337,500 annually to Florida growers.

CONTROL MEASURES

Stevens and Hall *(74)* stated that the use of fungicides for the control of downy mildew was discovered in 1883 by Millardet in France. Millardet experimented with it in 1884-85 and reported on the results in 1885. He was attempting to secure the control of the downy mildew of grape caused by a fungus closely related to the one causing downy mildew of cucumber. Scribner *(61)* conducted the first spraying experiments for the control of downy mildew diseases in the United States in 1885 and 1886. In these experiments Scribner used Gironde's mixture, now known as bordeaux mixture, Andoynand's formula for eau celeste, our ammoniacal copper carbonate, David's Powder, a form of evaporated bordeaux mixture and sulfated sulfur. These fungicides were first used to control mildew of grapes and late blight of potatoes. Halsted *(32)* used the above mentioned fungicides on cucumbers in New Jersey and considered bordeaux mixture the best for the control of downy mildew, followed by copper sulfate, eau celeste, and potassium sulfide in the order named. Hume *(35)* reported good control of this disease in Florida by the use of 4-4-50 bordeaux mixture. Almost all of the investigators *(1) (2) (11) (14) (17) (34) (40) (46) (48) (56) (70) (85)* have recommended bordeaux at various strengths for the control of this disease. Sayre *(60)* preferred copper-lime dust in Illinois while Brigs *(4)* used sulfur in Guam. Doran *(17)* found that sulfur was toxic to cucumbers and consequently used copper-lime dust. Garman *(23)* reported good results from the use of liver of sulfur and seven applications of bordeaux. Higgins *(34)* found copper acetate and colloidal copper to be of value in controlling the disease in Georgia, but reported that these materials burned the foliage. Sturgis *(80)* reported unsatisfactory results from the use of bordeaux mixture in Connecticut. Stewart *(71)* and Geise *(24)* reported good results with bordeaux mixture in years when the disease appeared, but in years when there was no disease the sprayed plants showed a reduced yield. Manns and Adams *(47)* consider that the control of the disease is impossible when seasonal conditions favor the development of the disease. Kock *(40)* reported that bordeaux sprays reduced the yield in Austria.

Recommendations in regard to the time of the first application, the number of applications and the manner of application in different states are quite variable. This may be explained on a basis of the differences in climatic conditions which occur in different localities. It is generally agreed *(14) (56) (69) (85)* that the first application should precede the appearance of the disease without any reference to the stage of development of the plant. Some investigators *(12) (13) (27) (63)* have considered it necessary to make the first application before the vines begin to run. Halsted *(28)* and Massee *(50)* urged the application of fungicides to both surfaces of the leaves. Sherbakoff *(69)* and Weber *(85)* recommended bordeaux mixture for the control of the disease in Florida, the first application to be made as soon as the true leaves appear and others at weekly intervals until the end of the season. Since downy mildew has caused considerable annual injury to cucumbers in Florida and since it usually appears early in the season, it is necessary to make the first application of fungicides early to obtain the best control.

Kock and Kornauth *(41)* have reported that certain climbing varieties of cucumbers have shown resistance to downy mildew. Thirty-seven commercial varieties of cucumbers were tested in a plot in Florida *(84)* but none of them showed any degree of resistance.

Without some means for controlling downy mildew the culture of cucumbers in Florida may result in a loss. Crop rotation, host resistance, field sanitation, and other means of controlling the disease have been attempted without success. The fungus does not attack the plant through the parts in contact with the soil. The only other logical means of controlling the disease appeared to be by means of fungicides applied to the growing plants in the field.

METHODS AND MATERIALS

It has been shown by investigators referred to previously that downy mildew of cucumbers can be controlled in certain localities through the proper use of fungicides. The beneficial effects of the fungicides are usually manifested by prolonging the life of the vines, thereby increasing the yield of fruit. Under Florida conditions where cucumbers are sold for consumption fresh, and the period during which they can be marketed at a profit is short, it is often necessary to discontinue picking before the vines cease to bear. On this account, there has been a demand for information concerning the advisability of using fungicides, even though downy mildew occurs every year and shortens the bearing period of the vines.

Accordingly, the experiments have been planned and conducted so as to obtain information concerning the effect of certain fungicides on the control of downy mildew [*Peronoplasmopara cubensis* (B. & C.) Clint.] under growing conditions in Florida. These experiments were conducted in commercial fields owned by certain well-known, capable growers in the immediate vicinity of Gainesville, Florida. The experiments were divided into plots, which were used as units in calculating the average results. The plots varied in size from one-fifteenth to one-third acre, the largest number of them being one-eighth to one-sixth acre. The size of some plots was limited by the number of plants growing in each plot. Occasionally, because of a poor stand of plants, the area was enlarged in order to reduce possible error in calculations. The plots were located in fields or portions of fields that showed wide variation in environmental conditions, such as soil type, moisture relations, cold protection, air drainage, exposure, slope, and culture.

The soil types are probably more influential than other environmental factors. Consequently, a brief description of the soil upon which each experiment was placed will be given. The seasonal developments of all the crops were comparable, since the planting seasons were uniform with very few extra early or late plantings. The fertilizers applied were also very much the same and the same kind of seed were planted in the different experimental plots. There were some variations in the cultural methods in the various experiments during any one season, and also from season to season, due primarily to the different types of soil and according to the cultural practices of the growers. The cooperative agreement adhered to was to the effect that the department of plant pathology furnished the fungicides, applied them, and assisted in recording the yield, while the growers cared for the experimental plots in the same manner as the remaining portion of the fields. The result of the agreement was to the effect that the grower secured the protection of his plants with fungicides with no cost to himself except the extra time required for the detailed count and measuring of the yield of the separate plots. He picked the fruit and measured the yield of each plot at each picking in hampers. The plots were staked and numbered so that the grower seldom knew the kind of fungicide applied to any specific plot. The yield was kept by plot number by the grower and a very impartial aspect surrounded the data accumulated thereby. This type of agreement worked very satisfactorily for all concerned. In fact, growers were often solicitous in the placing of the experiments.

The fungicides applied consisted of several kinds of commercial products and the standard copper sprays and dusts. Rock and hydrated lime were used in preparing bordeaux mixture, to determine their relative merits. Commercial forms of calcium caseinate, which functions as a spreader and sticker, were added to certain sprays. The bordeaux mixture was made up from stock solutions immediately before use, in lots of three gallons. The stock solutions of copper and lime were measured carefully and diluted before being mixed and in mixing the diluted copper solution was poured into the diluted lime solution, which was well stirred. The ingredients for the bordeaux mixture consisted of granulated bluestone (copper sulfate) and rock lime or the commercial builder's hydrated lime. These materials were always of the best commercial grade obtainable. The dusts were purchased in large lots and stored in air-tight containers. The required portions were taken to the experimental plots for application. Separate dusters were used for the different kinds of dust so as to avoid mixtures in the separate plots. The dusts were applied in the early morning when the plants were wet with dew. Upon drying, the dusts adhered very well to the plants. The cloud of dust usually rose less than three feet above the plants and settled rapidly, because there was seldom interfering wind or air currents at this time of day. The sprays were applied usually in the afternoons when the plants were dry with a substantial hand sprayer of the knapsack type that held about three gallons of spray. It was equipped with an extension rod and a fine nozzle adjusted so as to spray both leaf surfaces easily. The dust was applied with a ball bearing hand duster of the latest type. It had a hopper of 10-pound capacity and an adjustable outlet by means of which the quantity applied was easily regulated. The spray was measured by the tank which held three gallons and the amount of dust used was determined by weighing the duster and its contents before and after the respective plots were dusted. The total amounts of fungicides used are given in the tables in gallons and pounds. In the following tables the column headed "costs" includes the cost of the fungicides plus the cost of application. The cost of materials was determined by the retail cost of them or the ingredients necessary to prepare them. The cost of labor was determined by the actual amount of time required to apply the fungicide. The total time and total number of gallons or pounds were recorded for the season and then calculated as to cost of applications, which was 80 cents per acre per application for dust and 2 cents per gallon for liquid spray. The applications were made at weekly intervals, amounting to a total of about five applications per season. The average labor cost for dusting as contained in the tables summarizing each season's results was obtained by averaging the number of applications in the different plots during that year and multiplying by 80 cents, the labor cost of dusting one acre. The materials, both sprays and dusts, were applied during the entire experiment by the same assistant.

The fruit was picked usually every other day with the exception of longer intervals at the beginning and at the end of the season. The yield per plot, as previously stated, was measured in field hampers by the grower before the fruit was sorted and graded. The grower was usually able to select the best fungicide by the indication of the yield. When the yields were almost the same, the grower always selected as best the plot producing the most uniform dark green color of fruit. The degree of control of the disease by the various fungicides in the experiments was determined by the yield obtained during the marketing season. Picking was discontinued when the market price dropped too low to warrant further shipments. Consequently, the total yield was greater in certain years than in others. The numerous tables presenting the data are made up of two distinct parts, i. e., the first half contains the exact figures as originally taken, while the second part consists of the averages of duplicates and replications and the whole calculated on the basis of one acre for convenience in making comparisons.

Downy mildew is a severe disease of cucumbers and quickly affects the yield of plants. The fungicides were applied to check this disease and it was considered that the yield would be a direct and definite measure of the value of the fungicide. In addition to the yield as a measure of the control of the disease the plots in certain experiments have been compared as to the amount of the disease that appeared on the foliage of the plants, calculated by the apparent percentage of green, yellow, and dead leaves.

A general field comparison of the plots was made by indicating the appearance of the healthiest plot at a high percent, such as 90 percent, the figure being entirely arbitrary. The other plots were compared with this plot and given a relative rank. In this way a comparison was made which in most instances almost corresponded with the comparison of the plots in the various experiments as determined by the actual yield.

There are a large number of factors that are influential in production of fruit that may be of considerable importance in determining the exact results. The most important of these factors are moisture, temperature, and market conditions. The disease may be commercially controlled but to no avail, if markets have slumped and the product cannot be sold profitably, or the disease may be commercially controlled and the produce sold at a good profit but the temperature may be so high or the rainfall so scanty that production is materially reduced. There are also factors to consider in the form of competition from other trucking sections. This competition is detrimental to the Gainesville section, especially during late or delayed seasons. Late killing frosts dipping deep into northern Florida usually cause a large area of the southern states to come into production at the same time.

These factors have been taken into consideration in planning the experiments that have been conducted. An attempt has been made to simulate the grower's situation in his endeavor to produce a crop profitably. The grower must fertilize, rotate, cultivate, pick, and market his crop. He must contend with fluctuations in rainfall and moisture and temperature, seed purity, insect and fungus damage, and labor, marketing and market conditions, all of which are more or less inter-related. These factors are different on every farm. Since the experimental plots have been placed on farms in different localities with different growers, there naturally has been considerable variation in methods, although fungicidal applications have been quite comparable. For this reason, there is a wide variation in the different experiments during each season and from year to year. It is known that bordeaux mixture or copper-lime dust will prolong the life of plants when downy mildew is prevalent and produce fruit in excess of untreated plants.

The purpose of these experiments was to determine, if possible, whether treatment of plants is profitable under existing Florida conditions. Consequently, the experiments were conducted under conditions confronting the farmer, except that fungicides were applied to certain plants.

EXPERIMENTS CONDUCTED DURING 1925

Three experiments were planned for the season of 1925; one was conducted in a field irrigated with an overhead sprinkler system, another was on unirrigated high land, while the third was on low land. Seed were planted during the last of February and the plants developed slowly because of cool weather. The first applications of the fungicides were made about the middle of April when the seedlings averaged three or four true leaves. The first report of the disease was April 20. The picking season began about May 1 and continued for about three weeks.

Experiment 1: — This experiment was located on low, wet sandy-loam soil bordered on one side by a small stream. The field was divided into nine parts, of which three were sprayed, three dusted, and three were left as checks. The first applications of the fungicides were made on April 9 and subsequent applications were made April 18 and 27, respectively. The picking was started May 4 and continued through the 25th. The data obtained from this experiment are shown in condensed form in Table I.

TABLE I.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 1—1925.

Plot		Fungicide		Cost			
No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers
10	1/6 A	4-4-50 bordeaux	49 gal.	$ .50	$1.00	3	69
11	"	copper-lime	13 lbs.	1.30	.40	3	73
12	"	check					66
13	"	4-4-50 bordeaux	49 gal.	.50	1.00	3	69
14	"	copper-lime	13 lbs.	1.30	.40	3	60
15	"	check					35
16	"	4-4-50 bordeaux	49 gal.	.50	1.00	3	33
17	"	copper-lime	13 lbs.	1.30	.40	3	29
18	"	check					15
Results calculated on basis of one acre.							
Repl.							
3	1 A	4-4-50 bordeaux	294 gal.	3.00	6.00	3	342
3	"	copper-lime	78 lbs.	7.80	2.40	3	324
3	"	check					232

The results given in the above table show that the yield from the sprayed plots was slightly greater than the yield from the dusted plots, and each of the treated plots showed a considerably higher yield than the check plots. The total cost per acre of spraying and dusting was about the same.

Experiment 2:—This experiment was located on dark, sandy-loam soil in a portion of an eight-acre field which was irrigated by an overhead sprinkler system. The seed were planted early, but the season was cool and the plants developed slowly. The first applications of fungicides was made on April 10. Three more applications were made, as follows, April 16, 29, and May 12. The first appearance of the disease was on April 20. Picking was started on the 29th day of April and continued until the 27th of May. The data obtained from the plots in this experiment are shown in condensed form in Table II.

The above data show that a heavy application of copper-lime dust was more beneficial than a heavy application of 4-4-50 bordeaux mixture. The liquid spray burned the plants in some cases but the detrimental effects were offset by the beneficial ones since the sprayed plot equalled the check plot in yield. However, the added cost of the spray places it in the unprofitable position in comparison with the copper-lime dust which showed a 72-hamper increase per acre at a cost of 41.6 cents per hamper.

TABLE II.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 2—1925.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
56*	1/4 A	check					84
57	1/4 A	4-4-50 bordeaux	100 gal.	$1.00	$2.00	4	74
58	1/4 A	copper-lime	65 lbs.	6.50	.80	4	92
59*	1/4 A	check					64

Results calculated on basis of one acre.

Repl.							
1	1 A	copper-lime	260 lbs.	26.00	3.20	4	368
2	1 A	checks					296
1	1 A	4-4-50 bordeaux	400 gal.	4.00	8.00	4	296

*Average yield 74.

A very interesting feature of this experiment was that the check plots yielded better during the first two weeks than the plots to which fungicides were applied. The yield per week for each plot for the season is shown in Table III.

TABLE III.—YIELD PER PLOT BY WEEKS IN FIELD HAMPERS FROM CUCUMBER PLOTS, WHICH WERE DUSTED, SPRAYED, AND UNTREATED IN EXPERIMENT 2—1925.

Plot		Fungicide	Yield in Hampers				
No.	Size		1st Week	2nd Week	3rd Week	4th Week	Total
56	1/4 A	Check	14	31	35	4	84
57	1/4 A	4-4-50 bordeaux	6	19	36	13	74
58	1/4 A	copper-lime	11	27	39	15	92
59	1/4 A	check	10	22	29	3	64
Total			41	99	139	35	314

The average yield of the check plots for the first week was 50 percent higher than that of the sprayed plots and 9 percent higher than that of the dusted plot, but during the second week it was only 19 percent higher than the sprayed plot and was out-yielded by the dusted plot. During the third week the results were reversed and the yields from the sprayed plot were 12 percent and from the dusted plot 19 percent greater than the average yield of the checks. During the fourth week the increase was still greater in favor of the sprayed and dusted plots, namely 72 and 77 percent, respectively. The total yields calculated on a one-acre basis of the dusted, sprayed, and check plots were 368, 296, and 296 hampers, respectively.

This variation in production is of considerable importance to the grower when the influence of competition and fluctuating market prices are considered.

TABLE IV.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 3—1925.

Plot		Fungicide		Cost			
No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers
51	1/8 A	check					38
52	1/8 A	copper hydroxide	51 gal.	$ .75	$1.02	4	48
53	1/8 A	4-4-50 R.* bord.	48 gal.	.48	.96	4	41
54	1/8 A	4-6-50 H.* bord.	47 gal.	.47	.94	4	47
55	1/8 A	Pyrox + kayso	48 gal.	1.92	.96	4	46.5
56	1/8 A	check					42
57	1/8 A	4-4-50 R. bord. + kayso	48 gal.	.48	.96	4	45
58	1/8 A	cop.-lime-arsen.	34 lbs.	3.40	.40	4	41.5
59	1/8 A	copper hydroxide + kayso	50 lbs.	.75	1.00	4	43
60	1/8 A	copper-lime	37 lbs.	3.70	.40	4	40
61	1/8 A	Pyrox	47 gal.	1.82	.94	4	36.5
62	1/8 A	4-6-50 H. bord. + kayso	48 gal.	.48	.96	4	42
63	1/8 A	copper-lime-arsenate	35 lbs.	3.50	.40	4	45
64	1/8 A	Kilrust	54 gal.	2.16	1.04	4	21
65	1/8 A	check					32
66	1/8 A	4-4-50 R. bord.	48 gal.	.48	.96	4	34

*R=rock lime. *H=hydrated lime.

Results calculated on basis of one acre.

Repl.							
2	1 A	copper hydrox.	404 gal.	$6.00	$8.16	4	364
5	1 A	4-4-50 bordeaux	384 gal.	3.84	7.78	4	334.4
3	1 A	cop.-lime-arsen.	282 lbs.	28.20	3.20	4	334.4
2	1 A	Pyrox	380 gal.	15.20	7.60	4	332
3	1 A	check					298.4
1	1 A	Kilrust	432 gal.	17.28	8.64	4	168

Experiment 3:—This experiment was located in the immediate vicinity of Gainesville on a low portion of a field without irrigation facilities. The soil was a dark-colored, sandy-loam that had been previously cultivated and planted to cucumbers and other vegetable crops. The first application of the fungicides was made April 11, when the plants were in the 4-6 leaf stage, followed by three other applications on April 18, April 27, and May 9, respectively. Picking began May 4 and continued until May 28. Table IV gives the information and data collected from the various plots in this experiment.

It may be seen from Table IV that the plots to which copper fungicides were applied gave larger yields as a group than the non-copper sprays or the checks. The yields of the individual plots treated with materials containing copper checked fairly closely. Copper hydroxide proved to be a little better in regard to yield, whereas bordeaux appeared to be better than the other copper fungicides when yield and cost of treatment were taken into consideration. The average yield for the copper fungicides was 341.2 hampers per acre as compared with 298.4 for the check plots and 168 for those sprayed with Kilrust. There appeared to be no consistent advantage of slaked rock lime over hydrated lime when additional amounts of the latter were used in making bordeaux mixture. The use of a spreader or sticker in liquid sprays on cucumbers did not prove to be of considerable advantage.

TABLE V.—SUMMARY AND CONSOLIDATION OF THE DATA OBTAINED IN EXPERIMENTS CONDUCTED DURING THE SEASON OF 1925 RELATING TO THE CONTROL OF DOWNY MILDEW OF CUCUMBERS.

Plot		Fungicide		Cost		Yield Hampers
Repl.	Size	Kind	Total Amt.	Mat'l	Labor	
2	1 A	Cop. hydroxide	404 gal.	$6.00	$8.16	364
7	1 A	copper-lime (1)	191 lbs.	19.10	2.93	334.7
9	1 A	4-4-50 bordeaux	356 gal.	3.56	7.12	332.6
2	1 A	Pyrox	380 gal.	19.10	7.60	332
8	1 A	check				272.9
1	1 A	Kilrust	432 gal.	17.28	8.64	168

(1) average 3⅔ applications.

Summary for Season 1925:—The experiments conducted during the 1925 season yielded considerable data relative to the value of fungicides for the control of downy mildew of cucumbers. The season was very favorable for the production of cucumbers even though the mildew showed up in midseason. The market prices held up well to the end of the season, which insured profitable returns for late pickings which resulted from the use of fungicides. The data for the 1925 season are summarized in Table V.

The copper hydroxide sprayed plots showed the greatest yield, while the Kilrust plot shows the lowest yield. These are indicative of what might be expected but because of the limited replications the information they convey should not be considered final. The other plots, however, were very uniform in yield and were considerably better than the check plots. By considering the increased yields in connection with the cost, bordeaux mixture proved to be decidedly more economical than any of the other fungicides. Comparisons were made of bordeaux mixture prepared with hydrated lime and with slaked rock lime but the differences were not consistent and definite enough to prove that one form is better than the other. Consequently, the hydrated lime will probably be used in the future, since it is more easily handled. A commercial form of calcium caseinate, Kayso, was used in the liquid sprays as a spreader and sticker. The season's results showed no marked and consistent difference where it was used and its use will be discontinued in sprays applied to cucumbers in the future. Sulfur, which is one of the active ingredients of Kilrust, was detrimental to the development of cucumber plants and will be discontinued as a spray, although further work should be conducted to determine the value of sulfur dusts of different compositions on cucumbers for the control of downy mildew. The picking season of 1925 was continued longer than usual on account of the continued good market prices, and the prolonged fruiting period resulting from spraying and dusting proved profitable. An increase in the total number of applications of the fungicides during the season would possibly be more advantageous during such years.

During the season there was considerable evidence of copper injury to sprayed plants. Some of the leaves showed yellow margins, while others appeared to be more or less hardened and would make a distinct rustling when brushed with the hand. In certain instances distinct burning of the leaves resulted from the bordeaux spray. Consequently, the strength of the bordeaux to be used in the future experiments will be prepared according to a 2-4-50 formula instead of the 4-6-50 formula, using hydrated lime.

EXPERIMENTS CONDUCTED DURING 1926

During this season five experiments were planned and conducted along lines similar to those of the previous season. These experiments were distributed over the Micanopy-Gainesville-LaCrosse cucumber-growing section. They were conducted in cooperation with the commercial growers and the yield of the different plots was taken as a direct measure of the control of the disease.

Plantings were made in the latter part of February and the early conditions were favorable for plant growth, resulting in rapid development of the plants. The first application of the fungicides was made April 19 when the plants averaged about three true leaves and was repeated at weekly intervals until five applications were made. The season continued quite favorable for the growth of the plants, except in certain fields where the land was sandy the crop suffered from lack of moisture. The experiments are discussed individually and the season's data for all the experiments are averaged and summarized in the following tables.

Experiment 1:—This experiment was located on a gently sloping field, the north end of which was high, dry, and quite sandy, while the south end was low, rich, and moist. The plots were small, but produced fair yields, considering the fact that the north end of all of the plots died prematurely, because of lack of moisture. The data obtained from this experiment are shown in Table VI.

TABLE VI.—Effect of Spraying and Dusting Cucumbers for the Control of Downy Mildew as Determined by the Increase in Yield. Experiment 1—1926.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
1	1/15 A	2-4-50 bordeaux	10 gal.	$ .10	$ .20	5	11
2	1/15 A	copper-lime	11 lbs.	1.10	.26	5	11.5
3	1/15 A	check					10
4	1/12 A	2-4-50 bordeaux	15 gal.	.15	.30	5	11
5	1/12 A	copper-lime	13 lbs.	1.30	.33	5	6
6	1/12 A	check					6.5

Results calculated on basis of one acre.

Repl.							
2	1 A	2-4-50 bordeaux	165 gal.	$1.65	$3.30	5	148.5
2	1 A	copper-lime	160 lbs.	16.50	4.00	5	122.2
2	1 A	check					114

The yields of these plots show that bordeaux mixture controlled the disease better than copper-lime dust. These experimental results indicate that the increased yield resulting from the use of copper-lime dust cost $2.50 per hamper, making its use undesirable, whereas the bordeaux spray produced an increase of 34½ hampers at a cost of 11½ cents per hamper.

Experiment 2:—This experiment was located on fertile, sandy-loam soil in a large, level field exposed on all but the north side. The fungicides were applied first April 21 and at weekly intervals thereafter until five applications were made. Picking was begun May 13 and was continued to the end of the month and stopped then because of low prices. The data obtained from these plots are shown in Table VII.

TABLE VII.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 2—1926.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
11	1/19 A	copper-lime	11.5 lbs.	$1.15	$ .21	5	13.5
12	1/19 A	check					12
13	1/19 A	2-4-50 bordeaux	12.5 gal.	.13	.26	5	13
14	1/58 A	check					4
15	1/6 A	copper-lime	35.5 lbs.	3.55	.66	5	21
16	1/6 A	2-4-50 bordeaux	41 gal.	.41	.82	5	41
17	1/6 A	check					43
18	1/6 A	copper-lime	35.5 lbs.	3.55	.66	5	37
19	1/6 A	2-4-50 bordeaux	41 gal.	.41	.82	5	46
Results calculated on basis of one acre.							
Repl.							
3	1 A	2-4-50 bordeaux	243.1 gal.	$2.43	$4.86	5	256.3
3	1 A	check					237.3
3	1 A	copper-lime	214.6 lbs.	21.46	4.00	5	219.7

The summary of the data in the above table shows that the plots sprayed with bordeaux mixture produced a considerably larger number of hampers of fruit than the plots dusted with copper-lime dust, which, in turn produced better than the check plots. The cost of the dust and its application was about twenty-five dollars per acre in comparison with less than eight dollars per acre for the cost and application of the bordeaux spray.

Experiment 3:—This experiment was located on a slightly-sloping section of a 10-acre field supplied with an overhead sprinkler irrigation system. The soil was a black sandy-loam well cultivated and fertilized. The application of the different fungicides was made first on April 19 and was repeated at weekly intervals until five applications were made. Table VIII contains the data obtained from the experimental plot.

TABLE VIII.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 3—1926.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
56	1/21 A	2-4-50 bordeaux	10 gal.	$ .10	$ .20	5	18
57	1/21 A	check					13
58	1/8 A	copper stearate	9 lbs.	1.35	.50	5	44
59	1/7 A	copper-lime	22 lbs.	2.20	.57	5	56
60	1/8 A	check					44.5
71	1/7 A	copper-lime	29 lbs.	2.90	.57	5	50.5
72	1/8 A	copper-lime	20 lbs.	2.00	.50	5	36
73	1/7 A	check					51
74	1/8 A	copper-lime	25 lbs.	2.50	.50	5	60.5
75	1/7 A	copper stearate	10 lbs.	1.50	.57	5	60
76	1/14 A	2-4-50 bordeaux	14 gal.	.14	.28	5	25.5
77	1/14 A	check					20

Results calculated on basis of one acre.

Repl.							
2	1 A	copper stearate	71 lbs.	$10.65	$4.00	5	386
4	1 A	copper-lime	194.2 lbs.	19.42	4.00	5	379.4
2	1 A	2-4-50 bordeaux	203 gal.	2.03	4.06	5	329
4	1 A	check					316.5

In the above table it is noted that copper-lime and copper stearate dusts both produced better yields of cucumbers than the bordeaux sprays or the check plots. At the same time the bordeaux plots produced better than the check plots. There is an added cost to the plots to which the fungicides were applied, thus the increased yields cost 21 cents, 37 cents and 46 cents per hamper, respectively, for the copper stearate, copper-lime, and 2-4-50 bordeaux treatments.

This experiment shows that all three fungicides proved beneficial. It also shows that the dusts were better in controlling the disease than the liquid spray, as shown by the respective yields which are taken as direct measures of the prevalence of the disease. The check plots which were located at frequent intervals in the experiment indicated the prevalence and severity of the disease and the degree of control produced by the fungicides.

Experiment 4:—This experiment was located on irrigated, low sandy-loam soil in the vicinity of Gainesville and was planned and conducted for the purpose of obtaining information on the relative merits of copper-lime dust and liquid bordeaux mixture. The first application of the fungicides was made April 24 when the plants were in the three-leaf stage and three other applications were made at weekly intervals during the following month. The data obtained from the experiment are presented in Table IX.

TABLE IX.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 4—1926.

Plot		Fungicide		Cost			
No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers
21	1/8 A	Copper-lime	23 lbs.	$2.30	$ .40	4	68.5
22	1/8 A	2-4-50 (H) bord.	27.5 gal.	.28	.55	4	77
23	1/8 A	check					56
24	1/8 A	copper-lime	23 lbs.	2.30	.40	4	66
25	1/8 A	2-4-50 (H) bord.	27.5 gal.	.28	.55	4	67
26	1/8 A	copper-lime	20.5 lbs.	2.05	.40	4	67
27	1/8 A	2-4-50 (R) bord.	27 gal.	.27	.54	4	66
28	1/8 A	check					68
29	1/8 A	copper-lime	20.5 lbs.	2.05	.40	4	65
30	1/8 A	2-4-50 (R) bord.	29 gal.	.29	.58	4	91
Results calculated on basis of one acre.							
Repl.							
4	1 A	2-4-50 bordeaux	222 gal.	$2.22	$4.44	4	602
4	1 A	copper-lime	174 lbs.	17.40	3.20	4	526.4
2	1 A	check					496

The check plots showed 18 percent less yield than the plots sprayed with bordeaux mixture. The yield from the plots dusted with copper-lime was also considerably less than that from the bordeaux plots.

Experiment 5:—This experiment was located on a gently sloping portion of a sandy, irrigated field protected on the north and west by trees. The local conditions were favorable for the early development of the seedlings. The first application of the fungicides was made April 27 when the plants were in the three-leaf stage and others were made at weekly intervals. This experiment was planned and conducted so as to determine, if possible, the number of applications of fungicides required to control downy mildew of cucumber. The data obtained from the experiment are shown in Table X.

TABLE X.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 5—1926.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
38	1/12 A	copper-lime	3 lbs.	.30	.06	1	27
39	1/12 A	copper-lime	6.5 lbs.	.65	.13	2	29.5
40	1/10 A	copper-lime	12 lbs.	1.20	.24	3	35
41	1/10 A	copper-lime	16.5 lbs.	1.65	.32	4	31
42	1/10 A	copper-lime	16.5 lbs.	1.65	.32	4	31.5
43	1/12 A	check					32.5
44	1/10 A	2-4-50 bordeaux	20.5 gal.	.21	.41	4	37
45	1/10 A	2-4-50 bordeaux	20.5 gal.	.21	.41	4	34
46	1/10 A	2-4-50 bordeaux	16.5 gal.	.17	.33	3	31
47	1/12 A	2-4-50 bordeaux	9 gal.	.09	.18	2	26
48	1/12 A	2-4-50 bordeaux	5 gal.	.05	.10	1	18.5

Results calculated on basis of one acre.

Repl.							
38	1 A	copper-lime	36 lbs.	$3.60	$ .80	1	324
39	1 A	copper-lime	78 lbs.	7.80	1.60	2	354
40	1 A	copper-lime	120 lbs.	12.00	2.40	3	350
41	1 A	copper-lime	165 lbs.	16.50	3.20	4	310
42	1 A	copper-lime	165 lbs.	16.50	3.20	4	315
43	1 A	check					390
44	1 A	2-4-50 bordeaux	205 gal.	2.05	4.10	4	370
45	1 A	2-4-50 bordeaux	205 gal.	2.05	4.10	4	340
46	1 A	2-4-50 bordeaux	165 gal.	1.65	3.30	3	310
47	1 A	2-4-50 bordeaux	108 gal.	1.08	2.16	2	312
48	1 A	2-4-50 bordeaux	60 gal.	.60	1.20	1	223

There is but very little difference in the yields of the various plots in relation to the number of applications of the fungicides. This may be the result, however, of the fact that little or no disease appeared until late in the picking period. The plots sprayed four times produced better than those sprayed or dusted only once. The real difference manifests itself when the dusted and sprayed plots are averaged and compared respectively with the check plot. In this instance, the check plot produced more than the average of either of the sprayed or dusted plots. The larger yield from the check plot showed that the spraying and dusting resulted in a loss not only in the cost of material and labor but in reduced yield. The conclusion is that the fungicides were detrimental to the plants in this experiment.

Summary for Season 1926:—The results of the five experiments conducted during the 1926 season are summarized in Table XI. The different experiments were located in cucumber fields that varied considerably in soil type, moisture relations, and cold protection. The mildew was prevalent in all fields during the season and was the limiting factor in production in most fields. The decrease in market prices toward the end of the season was important in relation to the success of numerous growers. Many fields were abandoned before the total yield was obtained because of market conditions. Whenever this was done the picking of the experimental plots was also concluded. In certain instances this procedure perhaps did not show the maximum effect of the fungicides in controlling downy mildew.

TABLE XI. — SUMMARY OF THE DATA OBTAINED IN EXPERIMENTS CONDUCTED DURING THE SEASON OF 1926 RELATING TO THE CONTROL OF DOWNY MILDEW OF CUCUMBERS.

Plot		Fungicides		Cost		
Repl.	Size	Kind	Total Amt.	Mat'l	Labor	Yield Hampers
2	1 A	Copper stearate[1]	71 lbs.	$10.65	$4.00	386
18	1 A	copper-lime[2]	141.5 lbs.	14.15	2.88	323.5
16	1 A	2-4-50 bordeaux	171.4 gal.	1.71	3.42	317
12	1 A	check				315.8

[1] 5 applications.

[2] Average 3.6 applications.

The above table shows that the plots dusted with copper stearate produced the largest yield. The yield was 70 hampers more per acre than the check plots and the cost of the treatment was only $14.65 per acre. However, with but two replications the data are not so significant as they might at first appear. The plots sprayed with 2-4-50 bordeaux mixture at an added cost of $6.00 over the check plots produced only two more hampers of cucumbers than the check plots, whereas the copper-lime dust at an added cost of about $17.00 produced less than eight more hampers than the checks. Therefore, neither of these fungicides was used profitably in the control of the disease. The plots dusted with copper-lime dust produced more than the check plots but costs of material and labor were too great. The general conclusions drawn from the season's work are that copper stearate dust controlled the downy mildew to such an extent that the increased yield cost 20 cents per hamper. On the other hand, neither copper-lime dust nor 2-4-50 bordeaux mixture produced sufficient increases in yield over the untreated plots.

EXPERIMENTS CONDUCTED DURING 1927

The experiments during this season were conducted along lines similar to those of 1926. The plots were located so as to include as wide a variation of conditions as possible.

Downy mildew was first observed May 6 and spread later over the whole section. A cool, rainy period assisted materially in the spread of the disease and destruction of the plants. The first application of the fungicides was made about the middle of April; the picking season began the latter part of April and continued until the middle of May.

Results of the experiments are given in detail below.

Experiment 1:—This experiment was located on the south slope of a sandy field that was not irrigated. The seed were planted in February and under the early favorable conditions grew well. The fungicides applied consisted of four dusts and two liquid sprays. There were also two check plots. The first applications were made April 13 when the plants had developed two true leaves and others followed at weekly intervals until six applications were made. The first pickings were made the last of April. The information obtained from this experiment is shown in Table XII.

The above table shows that the check plots produced the highest yield, whereas the yield from the plots to which fungicides were added, both spray and dust, varied considerably. It is possible that the checks may have been slightly favored by better locations in the field, especially in regard to moisture, since the season turned out to be quite dry. It does not seem, from past experiences, that the various fungicides should all prove detrimental to fruit production, to such an extent as in this experiment.

Downy mildew did not show up until the latter part of the picking season and the actual influence of this disease on the yield is debatable. Notes taken on the experiment show that on the 6th of May all the plots were healthy and green with occasional blossoms appearing. At this time the disease was appearing in local areas in nearby fields. On May 16 all the plants in the experiments were more or less yellow because of the disease;

the check plots showed the disease most conspicuously. About this time most of the picking operations ceased because of low market prices. On May 27 the sulfur and bordeaux plots were the best in the experiment. They showed the least disease, while the check plots were both entirely dead. Another important factor was that the marketing conditions during this season were not satisfactory, consequently resulting in the early abandoning of the fields. This situation can be discerned in the low average yields of the various plots in this experiment.

TABLE XII.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 1—1927.

Plot		Fungicides		Cost			
No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers
11	1/8 A	Colloidal sulfur	35 lbs.	$1.08	$ .60	6	10.5
12	1/8 A	2-4-50 bordeaux	18 gal.	.18	.36	6	10.5
13	1/8 A	check					12.5
14	1/8 A	copper carbonate	21 lbs.	3.15	.60	6	13
15	1/8 A	Pyrox	18 gal.	1.50	.36	6	13
16	1/8 A	check					15
17	1/8 A	copper-lime	31 lbs.	2.48	.60	6	12.75
18	1/8 A	copper stearate	20 lbs.	3.00	.60	6	9
Results calculated on basis of one acre.							
16 & 13	1 A	check					110
14	1 A	copper carbonate	168 lbs.	25.20	4.80	6	104
15	1 A	Pyrox	144 gal.	12.00	2.88	6	104
17	1 A	copper-lime	248 lbs.	19.84	4.80	6	102
12	1 A	2-4-50 bordeaux	144 gal.	1.44	2.88	6	84
11	1 A	sulfur	280 lbs.	8.64	4.80	6	84
18	1 A	copper stearate	160 lbs.	24.00	4.80	6	72

Experiment 2:—This experiment included a field of cucumbers planted on sandy soil with a gentle northern slope and protected on the north by native woods. The soil was of good quality and not irrigated. This experiment was conducted to compare the beneficial effects obtained from different numbers of applications of the fungicides as determined by the yield of fruit. The plots consisted of checks and those plots to which 1, 2, 3, and 4 applications of the fungicide, both spray and dust, were made, at weekly intervals beginning April 14.

TABLE XIII.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 2—1927.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
20	1/8 A	2-4-50 bordeaux	5 gal.	$ .05	$ .10	1	32
21	1/8 A	2-4-50 bordeaux	8 gal.	.08	.16	2	30
22	1/8 A	check					29
23	1/8 A	2-4-50 bordeaux	12 gal.	.12	.24	3	34
24	1/8 A	2-4-50 bordeaux	16 gal.	.16	.32	4	33
25	1/8 A	check					32
26	1/8 A	copper-lime	18 lbs.	1.44	.40	4	26
27	1/8 A	copper-lime	12 lbs.	.96	.30	3	24
28	1/8 A	check					21
29	1/8 A	copper-lime	7 lbs.	.56	.20	2	20
30	1/8 A	copper-lime	4 lbs.	.32	.10	1	17
Results calculated on basis of one acre.							
20	1 A	2-4-50 bordeaux	40 gal.	$ .40	$ .80	1	256
21	1 A	2-4-50 bordeaux	64 gal.	.64	1.28	2	240
23	1 A	2-4-50 bordeaux	96 gal.	.96	1.92	3	272
24	1 A	2-4-50 bordeaux	128 gal.	1.28	2.56	4	264
22–25–28	1 A	check					218.6
26	1 A	copper-lime	144 lbs.	11.52	3.20	4	192
27	1 A	copper-lime	96 lbs.	7.68	2.40	3	168
29	1 A	copper-lime	56 lbs.	4.48	1.60	2	160
30	1 A	copper-lime	32 lbs.	2.56	.80	1	136

The final averages of the above table show that the plants sprayed with bordeaux mixture 2-4-50 produced the greatest amount of fruit, while the plants dusted with copper-lime dust produced considerably less fruit than the check plants. Close examination shows that all of the sprayed plots produced more fruit than any of the dusted plots and with one exception all of the sprayed plots produced more fruit than any of the check plots. Two of the check plots produced more than any dusted plot. No explanation can be given to account for these variations in yield. The dusted plants show a gradual increase in production of fruit in direct proportion to the number of applications of the fungicide. Thus the plot dusted four times produced the most fruit of any dusted plot. In considering the sprayed plots, however, those sprayed once produced almost as much as those sprayed four times. Since picking was discontinued because of a slump in the market price, the differences in yields are not as large as they might have been if all of the later fruit had been picked. Those plants growing in low places were green and growing as compared with the wilted plants on high ground, but were spotted somewhat with the disease. As far as the applications of spray were concerned, one was as good as four and the operation was profitable. In respect to the applications of dust, there is no other conclusion than that the dusts were detrimental to the plants and their production of fruit and, in addition, the expense of the fungicide and its application was a total loss.

Experiment 3:—The plots in this experiment were located in a portion of a six-acre field that had been planted to cucumbers for a number of successive seasons. The soil was a rich sandy-loam, almost level, which was irrigated with an overhead sprinkler system. The seed were planted early in March and a good stand resulted. The fungicidal dusts were applied weekly beginning April 13. Table XIV contains the information obtained from the different plots in this experiment.

TABLE XIV.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 3—1927.

Plot		Fungicides		Cost			
No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers
1	1/8 A	colloidal sulfur	52 lbs.	$ 1.56	$ .60	6	44.5
2	1/8 A	copper carbonate	44 lbs.	6.60	.60	6	51
3	1/8 A	check					59
4	1/8 A	copper-lime	46 lbs.	3.68	.60	6	49
Results calculated on basis of one acre.							
3	1 A	check					472
2	1 A	copper carbonate	352 lbs.	$42.80	$4.80	6	408
4	1 A	copper-lime	368 lbs.	29.44	4.80	6	392
1	1 A	colloidal sulfur	416 lbs.	12.48	4.80	6	336

In this experiment the check plot yielded a much larger crop than the dusted plots. This can partially be explained by the fact that the check plot was growing on a little more fertile plot of soil. The seedlings emerged first in this plot and all during the season grew and produced better than the other plots. The disease was not an important factor in this experiment until the last week of the picking season. The picking was stopped because the market prices dropped too low to make further picking, packing, and selling profitable. No detrimental effect of the dusts on the plants could be detected, except a slight hardening of the leaves and petioles of the plants dusted with sulfur. The results of this experiment show that the application of fungicides to these plants for the control of downy mildew did not increase the yield.

Summary for Season 1927:—The early part of the season was most favorable for the growth of cucumbers, but owing to the lack of rainfall, later production was considerably reduced. The following rainfall was recorded: March 2.33″, April 1.46″, and May .46″, which was much below normal for April and May. Where irrigation was not practiced, the plants wilted in most fields during the latter part of the picking season. Downy mildew was first detected in this vicinity on May 6 and gradually spread until all plants were killed. A few cool, rainy days about May 12-14 favored the spread and development of the disease which resulted in a rapid killing of the plants during the following week. Usually the picking seasons have continued until the vines are entirely dead, whereas the picking season of the current year was concluded principally because of the low market price.

The data obtained from the experiments conducted during the season are averaged and summarized in Table XV.

TABLE XV.—SUMMARY OF THE DATA OBTAINED IN EXPERIMENTS CONDUCTED DURING THE SEASON OF 1927 IN RELATION TO THE CONTROL OF THE DOWNY MILDEW OF CUCUMBERS.

Plot		Fungicide		Cost		Yield Hampers
Repl.	Size	Kind	Total Amt.	Mat'l	Labor	
6	1 A	check				266.8
2	1 A	cop. carbonate[1]	239 lbs.	$35.85	$4.80	256
6	1 A	copper-lime[2]	270 lbs.	21.60	3.52	219.3
2	1 A	sulfur[1]	352 lbs.	10.56	4.80	210
5	1 A	2-4-50 bordeaux	145 gal.	1.45	2.90	167
1	1 A	Pyrox	144 gal.	12.00	2.88	104
1	1 A	copper stearate[1]	160 lbs.	24.00	4.80	72

[1] Average 6 applications. [2] Average 4.4 applications.

The results listed in the above table show conclusively that fungicides did not increase the yields of cucumbers in the 1927 experiments. The check plots produced more fruit than the plots of the same size to which fungicides were added in various amounts and of different constituents. The cause for this cannot be explained. In addition to the decreased yields of the treated plots in comparison with the checks, the cost of material and labor must be added to the loss suffered because of the reduced yield. Copper carbonate dust plots produced almost as much as the checks, and the fruit was much better appearing than that in the check plot, because of its darker, uniform green color. However, the excessive costs of this fungicide did not justify its use this season. The low yields obtained from the plots treated with the other fungicides cannot be satisfactorily explained.

EXPERIMENTS CONDUCTED DURING 1928

The general plan of the experiments conducted during the 1928 season was similar to that of the previous season. The various plots were located in the immediate vicinity of Gainesville, on farms of commercial growers.

The 1928 season opened very early. The seed were planted in February and the plants developed rapidly until cool weather early in March stopped their growth and froze large areas. Replantings were made and by the middle of April the new plants had developed several leaves and were large enough for the first applications of fungicides. At this time none of the plants in any of the plots had developed runners or had blossomed. In fact the plants in one of the plots were barely past the cotyledon stage at this time. The first pickings were made the second week in May, at which time the first signs of downy mildew were noticeable. The picking season continued until the first of June and during this time downy mildew gradually involved more and more of the fields until most of the plants were dead. At the end of the picking season the various plots in the respective experiments were compared as to the amount of healthy green plants, diseased plants, and dead plants.

Experiment 1:—This plot was on a portion of a six-acre field that was irrigated with an overhead sprinkler system. The soil, a light sandy loam, was almost flat. This field had been planted to cucumbers for a series of years and the successive crops appeared to be poorer and poorer. Previous to this year's planting stable manure had been applied to the whole field. The field had always been carefully cared for and cultural methods were above the average. At certain times in the spring, windblown sand had caused some injury to seedlings. The field was planted early and because of the freezing temperatures it was replanted. Continued cold weather caused the seedlings to become stunted. In fact their growth was stopped for a considerable period during March and April. After the advent of warm weather the plants still ceased to grow well and further examination showed that the plants in the whole field were badly infested with root knot [*Heterodera radicicola* (Greef) Mueller]. The first application of fungicides was made April 17 before any of the plants were blooming or putting out runners. The data obtained from this plot during the season are shown in Table XVI; it is also calculated on an acre basis.

TABLE XVI.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 1—1928.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
1	1/8 A	copper-lime	26 lbs.	$2.08	$ .60	6	7
2	1/8 A	sulfur	37.5 lbs.	1.12	.60	6	13.3
3	1/8 A	copper carbonate	27 lbs.	4.05	.60	6	11.75
4	1/8 A	check					14.5
Results calculated on basis of one acre.							
4	1 A	check					116
2	1 A	sulfur	300 lbs.	$9.00	$ 4.80	6	106.4
3	1 A	copper carbonate	216 lbs.	32.40	4.80	6	94
1	1 A	copper-lime	208 lbs.	16.64	4.80	6	56

Beginning with the 17th of April the plants in these plots made very little growth for three weeks. During this period and afterward the check plot looked the best. A few plants developed but it was found that the root-knot was too bad to expect the plants to develop very much. The plants showed no signs of downy mildew until close to the end of the season but after it appeared, the plants in the check plot were killed almost entirely before the plants in the other plots showed any injury. The check plot had less nematode infestation than any of the other plots which accounted, in part, for the larger yield. Under these conditions no benefit was derived from spraying.

Experiment 2:—This experiment was located on newly cleared land of a sandy-loam type, slightly rolling with a gradual slope toward the south. The field, about eight acres in size, was well protected on all sides by native woods except a small portion to the northeast. It was irrigated by an overhead sprinkler system; the water was pumped by engine from a nearby brook. The first application of fungicides was made April 15 when the plants had developed four leaves and the others followed at weekly intervals. Six applications were made during the season. Picking was begun on May 12 and continued into the first week of June. The data collected from these plots are included in Table XVII.

TABLE XVII.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 2—1928.

Plot		Fungicide		Cost			
No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers
72	1/8 A	copper stearate	20.5 lbs.	$ 3.07	$ .60	6	42
73	1/8 A	check					36
74	1/8 A	sulfur	43 lbs.	1.29	.60	6	32
75	1/8 A	copper-lime	36 lbs.	2.88	.60	6	39
76	1/8 A	check					43
77	1/8 A	2-4-50 bordeaux	35 gal.	.35	.70	6	55
78	1/8 A	copper carbonate	37 lbs.	5.55	.60	6	49
Results calculated on basis of one acre.							
77	1 A	2-4-50 bordeaux	280 gal.	$ 2.80	$5.60	6	440
78	1 A	copper carbonate	296 lbs.	44.40	4.80	6	392
72	1 A	copper stearate	164 lbs.	24.60	4.80	6	336
73 & 76	1 A	check					316
75	1 A	copper-lime	288 lbs.	23.04	4.80	6	312
74	1 A	sulfur	344 lbs.	10.32	4.80	6	256

The yields of the plots in this experiment as shown above indicate that 2-4-50 bordeaux mixture gave the best control of the disease and at an exceedingly low cost. The sulfur plot gave the lowest yield and all during the season was rated as the poorest in the experiment in regard to growth, color, and the amount of the disease present. The check plot developed the diseases more rapidly than the sulfur plot but previous to the advent of the disease, the check plot developed much better than the plants covered with sulfur. Both the copper carbonate and the copper stearate plots produced more than the check plots, thus showing a partial control of the disease. However, when the costs are considered, neither of these two fungicidal dusts proved to be profitable. The former showed an increase of 76 field hampers at a cost of slightly over $50, or 65 cents per hamper for the increased yield, whereas the bordeaux plot showed an increase of 120 field hampers at an increased cost of $8.40 or 7 cents per hamper for the increased yield. The copper-lime plot yielded about the same as the check. The quality of fruit was the best on the copper stearate plot, especially in respect to the color, which was a much darker uniform green, very desirable for the market. At the end of the picking season the plots were examined and compared with each other in relation to general appearances. At this time the check plots which were the poorest showed 100 percent infection and from 50 to 80 percent of the plants were dead. The plants in the copper carbonate plot were all green and showed only 30 percent infection. They were of a good color, except that the margins of some leaves were slightly yellowish, probably caused by the copper. The other plots to which fungicides were applied were quite uniform in appearance with the exception of the sulfur plot which was yellowish (not because of the color of the sulfur), in contrast to a dark green color of the plots dusted with copper. The plants dusted with sulfur were smaller and seemed to be more rigid than those of other plots. However, the sulfur plot showed less disease than the check plots.

Experiment 3:—This experiment was located in a sandy, six-acre field with a considerable eastern slope and had previously been a cowpen. The soil was not the thirsty type and no irrigation was provided. A fine stand of seedlings was obtained and they grew rapidly. The first fungicides were applied April 15 when the plants were in the four-leaf stage, and the other applications followed at weekly intervals. The first picking was made May 18. The experiment contained seven plots, the data from which are contained in Table XVIII.

In this experiment the copper stearate plot gave the largest yield, followed closely by the plot sprayed with bordeaux. The plot dusted with copper stearate not only produced the most fruit, but the vines looked best during the entire season and the fruits were of a desirable uniform dark green color. In each of these plots less than 10 percent of the plants were infected when picking was discontinued on account of market conditions. The check plots produced better than either the sulfur or copper-lime plots. This advantage was gained early in the season before the disease developed. The check plots were the first attacked by the

TABLE XVIII.—Effect of Spraying and Dusting Cucumbers for the Control of Downy Mildew as Determined by the Increase in Yield. Experiment 3—1928.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
50	1/8 A	copper stearate	18 lbs.	$ 2.70	$ .60	6	28
51	1/8 A	check					18.5
52	1/8 A	sulfur	49.5 lbs.	1.48	.60	6	19
53	1/8 A	copper carbonate	35.5 lbs.	5.32	.60	6	22.5
54	1/8 A	2-4-50 bordeaux	45 gal.	.45	.90	6	25
55	1/8 A	check					19.5
56	1/8 A	copper-lime	32 lbs.	2.56	.60	6	18.5

Results calculated on basis of one acre.

No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers
50	1 A	copper stearate	144 lbs.	$21.60	$4.80	6	224
54	1 A	2-4-50 bordeaux	360 gal.	3.60	7.20	6	200
53	1 A	copper carbonate	284 lbs.	42.50	4.80	6	180
51 & 55	1 A	check					152
52	1 A	sulfur	396 lbs.	11.84	4.80	6	152
56	1 A	copper-lime	256 lbs.	20.48	4.80	6	148

disease and they showed 100 percent infection, were badly yellowed, and numbers of plants were killed when picking was discontinued. Most of the other plots showed from 10 to 30 percent infection. The copper stearate and copper carbonate produced increased yields at a cost of 36 cents and $1.68 cents per hamper, respectively. The bordeaux plot showed an increase in yield of 48 hampers per acre at an added cost of only $10.80 or 22½ cents per hamper for the increase.

Experiment 4:—This experiment was located on a piece of sandy soil that sloped northward to a wooded stream. The soil was rich but not irrigated. The plantings were made early and a good stand of plants was obtained earlier than on any other fields in the immediate vicinity. The first application of fungicides was made April 17, when the plants were in the four-leaf stage, at which time half of the plot was sprayed with 2-4-50 bordeaux mixture and the other half dusted with 20-80 copper-lime dust, with the exception of the checks. Other applications followed at weekly intervals for four applications. Two plots were left untreated for checks, while others received one application, two applications, three applications, and four applications at successive weekly intervals. It was considered best to make the applications at the beginning of the season where only one treatment was to be made. The first pickings were made May 7 and the season continued until June 1. The data obtained from the plots in this experiment are shown in Table XIX.

TABLE XIX.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 4—1928.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
5	1/6 A	copper-lime	28.5 lbs.	$ 2.28	$ .53	4	40
6	1/6 A	2-4-50 bordeaux	30 gal.	.30	.60	4	48
7	1/6 A	copper-lime	17.5 lbs.	1.40	.40	3	34.5
8	1/12 A	check					19
9	1/6 A	2-4-50 bordeaux	21 gal.	.21	.42	3	31
10	1/6 A	copper-lime	9 lbs.	.72	.26	2	30.2
11	1/12 A	check					15
12	1/6 A	2-4-50 bordeaux	14 gal.	.14	.28	2	23
13	1/6 A	copper-lime	3 lbs.	.24	.13	1	24.3
14	1/6 A	2-4-50 bordeaux	6 gal.	.06	.12	1	21.5
Results calculated on basis of one acre.							
5	1 A	copper-lime	171 lbs.	$13.68	$3.20	4	240
6	1 A	2-4-50 bordeaux	180 gal.	1.80	3.60	4	288
7	1 A	copper-lime	105 lbs.	8.40	2.40	3	207
9	1 A	2-4-50 bordeaux	126 gal.	1.26	2.52	3	186
8 & 11	1 A	check					204
10	1 A	copper-lime	54 lbs.	4.32	1.60	2	181.2
12	1 A	2-4-50 bordeaux	84 gal.	.84	1.68	2	138
13	1 A	copper-lime	18 lbs.	1.44	.80	1	145.8
14	1 A	2-4-50 bordeaux	36 gal.	.36	.72	1	129

The data in the above table show that the yield of plots receiving four applications of the fungicide was almost double that of the plots receiving but a single application. The yields, which are taken as indirect measures of the amount of disease present, show a gradual increase with each successive application of fungicide. It is of interest to note, however, that only the plots to which four applications were made produced more cucumbers than the average of the check plots. On account of the high cost of the copper-lime dust there is some question as to the advisability of its use. However, the increase in yield of the sprayed plot over the dusted plot to which four applications were made and the lower cost of the spray places it in a very favorable position for recommendation.

It is also evident that one, two, or even three applications were of little value. In fact none of these plots so treated exceeded the check plots in production. One and two treatments were exceedingly detrimental as indicated by the results. It might be added however that this part of the plot became a little dry during the end of the season and some reduction in yield may be accounted for in this way. The check plots showed signs of infection first and the disease spread over them very rapidly. The disease spread gradually to the plots to which the fewer applications of fungicides were made, then successively to the others in rotation depending on the number of applications they received. When the check plants were dead the plants which were sprayed and dusted four times showed from 20 to 40 percent infection and were not suffering materially from the disease. Picking was discontinued abruptly because the fruit could not be marketed profitably, thus preventing a greater possible difference between checks and treated plants.

Summary for Season 1928:—The season was favorable for the growth of cucumber plants in most sections of central Florida in spite of several cold periods and occasional replanted fields. The experiments were planned and conducted along lines similar to those of the previous season. They were located with experienced growers in different localities and under various conditions. The different experiments have already been described in detail. The results obtained from all four experiments are averaged, calculated on an acre basis, and shown in Table XX.

TABLE XX.—SUMMARY OF THE DATA OBTAINED IN EXPERIMENTS CONDUCTED DURING THE SEASON OF 1928 IN RELATION TO THE CONTROL OF THE DOWNY MILDEW OF CUCUMBERS.

Plot		Fungicides		Cost		
Repl.	Size	Kind	Total Amt.	Mat'l	Labor	Yield Hampers
2	1 A	copper stearate	116 lbs.	$23.10	$4.80	280
4	1 A	2-4-50 bordeaux	219.2 gal.	2.19	4.39	275
3	1 A	cop. carbonate	265 lbs.	39.78	4.80	222
7	1 A	check				195
4	1 A	copper-lime	255.5 lbs.	16.78	3.20	177.4
3	1 A	sulfur	313 lbs.	10.39	4.80	171.5

It may be seen from Table XX that the copper stearate plots produced the greatest yield, which is interpreted as resulting in the best control of the disease. This fungicide was applied as a dust to the cucumber plants in the early mornings when they were still wet with dew. These plots averaged 85 field hampers of fruit to the acre more than the check plot at an additional cost of $27.90. The cost amounted to approximately 32 cents per hamper for the increase in yield and would possibly raise the production cost too high. The total cost of the increase in yield of the plots sprayed with 2-4-50 bordeaux was $6.58 or 8.2 cents per hamper for the increase in yield. The increase in yield was produced at a cost of 8.2 cents per hamper, as compared with 32 cents per hamper for the increase in yield resulting from the use of copper stearate. Although the plots sprayed with bordeaux did not produce the highest yield, the production costs were enough less to place the operation in a favorable light with the grower. The copper carbonate plots yielded better than the checks, but the high cost of the increased yield per hamper, which was $1.65, made its use prohibitive. The other dusts, sulfur and copper-lime, did not produce as much as the check plots.

EXPERIMENTS CONDUCTED DURING 1929

The experiments were planned and conducted in 1929 about the same way as they were the previous season. The different plots were distributed over the cucumber section in the immediate vicinity of Gainesville.

The season was considered early and the seedlings developed rapidly from early plantings due to favorable temperatures and adequate rainfall. Because of the earliness of the season and the rapid growth of the seedlings early in the season, it was thought possible that they might escape downy mildew. Careful observations were made daily for the first appearance of the disease. On March 30 the first diseased leaves were found and the first applications of fungicides were made on that day. At this time the more advanced plants had developed short runners and were in blossom. The fungicides were applied thoroughly with hand machinery and the treatments were repeated once a week until the close of the picking season. The first pickings were made April 22 and by May 12 the season was over because the disease had killed the plants.

Experiment 1:—This plot was located on light hammock soil and was a portion of a 12-acre field that had been cleared the previous season. The whole field sloped gently and was supplied with an overhead sprinkling system of irrigation.

The first application of fungicides was made on the 30th of

March, at which time the cucumber plants had begun to develop runners, were showing about a dozen leaves and an occasional blossom. Other applications were made at weekly intervals for five weeks.

The data obtained from the experimental plots are shown in Table XXI.

TABLE XXI.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 1—1929.

Plot		Fungicides		Cost			
No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers
1	1/16 A	sulfur	12.5 lbs.	$ .38	$ .25	5	15.7
2	1/8 A	2-4-50 bordeaux	17 gal.	.17	.34	5	45.5
3	1/16 A	check					18.2
4	1/8 A	copper-lime	12.5 lbs.	1.00	.25	5	53.5
5	1/8 A	copper stearate	6.7 lbs.	1.01	.25	5	52
6	1/16 A	check					22.7
7	1/8 A	2-4-50 bordeaux	17 gal.	.17	.34	5	62
8	1/8 A	cop. carbonate	11 lbs.	1.65	.25	5	57
9	1/16 A	sulfur	12.5 lbs.	.38	.25	5	25
10	1/8 A	2-4-50 bordeaux	17 gal.	.17	.34	5	47.5
11	1/16 A	check					22.7
12	1/8 A	copper-lime	12.5 lbs.	1.00	.25	5	53.7
13	1/8 A	copper stearate	7 lbs.	1.05	.25	5	60.5
14	1/16 A	check					23.7
15	1/8 A	2-4-50 bordeaux	17 gal.	.17	.34	5	54
16	1/8 A	cop. carbonate	11 lbs.	1.72	.25	5	43.5
Results calculated on basis of one acre.							
Repl.							
2	1 A	copper stearate	55 lbs.	$ 8.25	$4.00	5	450
2	1 A	copper-lime	100 lbs.	8.00	4.00	5	429
4	1 A	2-4-50 bordeaux	136 gal.	1.36	2.72	5	417.5
2	1 A	cop. carbonate	90 lbs.	13.50	4.00	5	402
4	1 A	check					350
2	1 A	sulfur	200 lbs.	6.00	4.00	5	326.5

In these experiments the extent of control of the disease obtained by the applications of fungicides was determined by the yield of fruit from the respective plots as was done in preceding years. The results show that copper stearate dust produced the greatest beneficial effect upon the yield. The other fungicides are listed in the order of their relative merits on this standard. All of the fungicides of which copper was the base apparently controlled the disease better than those which contained no copper. They did not, as far as could be determined, prove to be detrimental in any way. The plants dusted with sulfur were slightly lighter green in color, grew less rapidly and extensively than the checks, and they were killed by the disease about the same time as the checks.

Experiment 2:—A portion of a 10-acre field of cucumbers was laid out for this experiment. It was located on the brow of a low bluff along a running stream and was surrounded on three and a half sides by native woods. This piece of land was of the sandy-loam, high hammock type that had been planted to cucumbers the previous season. The field was irrigated by an overhead sprinkler system. The seed were planted early and the plants grew rapidly under favorable conditions. The first application of fungicides was made March 31, when the plants were large, showing an average of a dozen leaves and an occasional blossom.

Table XXII contains the classified data obtained from this experiment.

TABLE XXII. — EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 2—1929.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
1	1/8 A	sulfur	18 lbs.	$ .54	$ .50	5	35.2
2	1/8 A	check					34.5
3	1/8 A	copper stearate	8.2 lbs.	1.23	.50	5	32.3
4	1/8 A	2-4-50 bordeaux	23 gal.	.23	.46	5	37.2
5	1/8 A	copper-lime	11.5 lbs.	.92	.50	5	43.7

Results calculated on basis of one acre.

No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers
1	1 A	sulfur	144 lbs.	$4.32	$4.00	5	282
2	1 A	check					276
3	1 A	copper stearate	66 lbs.	9.90	4.00	5	258
4	1 A	2-4-50 bordeaux	184 gal.	1.84	3.68	5	298
5	1 A	copper-lime	92 lbs.	7.36	4.00	5	350

The disease showed up first in the check plot close to the edge of the woods. This plot contained the largest, most rapidly growing plants, probably as a result of protection by the woods on the north. The copper-lime and bordeaux plots produced the most fruit while the plot dusted with copper stearate produced the lightest yield. This low production may be due to considerable mosaic that developed in one end of the plot, as the vines remained green two weeks after the check plots were dead.

Experiment 3:—This experiment was located in a field of dark sandy-loam soil. At the time the first application of fungicides was made the plants were in blossom and downy mildew was evident on a few plants in the field. The field was selected because it was in about the same condition that most fields are in when the owners put on their first application, i.e. the disease must be in the field and plainly evident before the grower recognizes the need of a fungicide. Three applications were made before the plants were killed by the disease. There is one less application on the plots in this experiment than any of the others conducted during 1929. Table XXIII includes the data obtained from the experiment.

TABLE XXIII.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 3—1929.

Plot		Fungicide		Cost			
No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers
1	1/8 A	copper-lime	14 lbs.	$ 1.12	$ .30	3	45
2	1/8 A	check					28
3	1/8 A	sulfur	16 lbs.	.48	.30	3	22
4	1/8 A	check					30
5	1/8 A	cop. carbonate	12 lbs.	1.80	.30	3	36
6	1/8 A	check					25
7	1/8 A	copper stearate	6.5 lbs.	.97	.30	3	22

Results calculated on basis of one acre.

No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers
1	1 A	copper-lime	112 lbs.	$ 8.96	$2.40	3	360
2	1 A	cop. carbonate	96 lbs.	14.40	2.40	3	288
3	1 A	check					222
4	1 A	copper stearate	52 lbs.	7.80	2.40	3	176
5	1 A	sulfur	128 lbs.	3.84	2.40	3	176

Because of the delay in making the first applications the whole field became infected. The fungicides aided materially in holding the disease in check but did not prevent the plants from being killed. The untreated plants died only a few days before the treated ones, and the plants in the whole plot died two weeks before those in Experiment 1. Two copper dusts showed up much better, however, than the check, which in turn was better than the plots dusted with sulfur and copper stearate.

Experiment 4:—This experiment was located on a relatively level piece of low, non-irrigated, dark, sandy-loam soil. An area of slightly more than an acre was divided into three portions, one was used as a check, one was sprayed with bordeaux, and the third was dusted with copper-lime dust. The fungicides were applied late, when the plants were in blossom. The disease was evident in the field at the time of the first application.

TABLE XXIV. — EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 4—1929.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
1	3/7 A	copper-lime	32 lbs.	$2.64	$1.36	4	83.5
2	1/6 A	check					23
3	3/7 A	2-4-50 bordeaux	60 gal.	.60	1.20	4	110.5
Results calculated on basis of one acre.							
1	1 A	2-4-50 bordeaux	140 gal.	$1.40	$2.80	4	257.8
2	1 A	copper-lime	77 lbs.	6.16	3.17	4	194.8
3	1 A	check					138

The disease, which was evident on the plants at the time of the first application of fungicides, was only slightly checked in its advance. The check plants were killed rapidly and the others soon followed. The plot sprayed with bordeaux far out-yielded the dusted plot and both exceeded the yield of the checks. The bordeaux plot remained green and vigorous for some time after the dusted plot was entirely dead because of the disease. In this experiment the fungicides were exceedingly profitable regardless of the lateness of their application.

Experiment 5:—This experiment was conducted on about a half-acre of a six-acre field that had grown cucumbers for a number of years. The soil was of a sandy-loam type and irrigated with an overhead sprinkler system. The plants were well advanced, being in blossom when the first applications of fungicides were made. There were four plots in the experiment; three were dusted with fungicides and the fourth was a check plot. The relatively light applications were made in order to determine their value in comparison to heavier applications.

The disease was evident in this plot at the time the first applications were made and steadily spread until the plants were killed. The fungicides checked the disease somewhat, as is shown by the yields of the plots. The yield of all the dusted plots exceeded that of the check plot. This is due to the checking of the disease during picking time and partly due to prolonging the life of the plants and picking season after the check plots were dead.

TABLE XXV. — EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 5—1929.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
1	1/8 A	check					9.5
2	1/8 A	copper-lime	6.7 lbs.	$ .54	$ .40	4	13
3	1/8 A	sulfur	8.5 lbs.	.26	.40	4	11.5
4	1/8 A	cop. carbonate	6 lbs.	.90	.40	4	19
Results calculated on basis of one acre.							
1	1 A	cop. carbonate	48 lbs.	$7.20	$3.20	4	152
2	1 A	copper-lime	54 lbs.	4.32	3.20	4	104
3	1 A	sulfur	68 lbs.	2.04	3.20	4	92
4	1 A	check					76

Summary for Season 1929:—To make the data more easily understood, the information accumulated from all five of the experiments conducted during the season, have been averaged under the different headings in Table XXVI. The replications vary somewhat depending on the duplications in the respective experiments. The cost item can be deduced at a glance by adding material and labor costs.

TABLE XXVI.—SUMMARY OF THE DATA OBTAINED IN EXPERIMENTS CONDUCTED DURING THE SEASON OF 1929 IN RELATION TO THE CONTROL OF DOWNY MILDEW OF CUCUMBERS.

Plot		Fungicide		Cost		Yield Hampers
Repl.	Size	Kind	Total Amt.	Mat'l	Labor	
6	1 A	2-4-50 bordeaux	144.6 gal.	$ 1.44	$2.88	372.1
5	1 A	copper-lime	96 lbs.	7.60	3.68	352.5
4	1 A	copper stearate	57 lbs.	8.55	3.68	333.5
4	1 A	cop. carbonate	81 lbs.	10.40	3.68	311
10	1 A	check				255.6
6	1 A	sulfur	148 lbs.	4.44	3.68	240.6

The replications vary because all of the fungicides were not used in all of the experiments and others were used more than once in the same experiment. The plots sprayed with 2-4-50 bordeaux mixture show a much better yield than the plots treated with any of the other fungicides and all treated plots produced a greater yield than the check plots with the exception of the sulfur plots. The liquid spray was also less expensive than any of the other fungicides. In comparing the yields of treated plots with the check, it will be found that the additional cost of the fungicide and its application was more than justified in every case except sulfur. The plots to which sulfur was applied produced a lower yield of fruit than the check plots for the season's average.

The bordeaux spray showed less detrimental effect on the plants this year than ever before. There was no burning of the leaves, the blossoms set fruit from the beginning of the season, and the bordeaux plots developed as rapidly as the checks throughout the season. The plants dusted with sulfur were not so dark green as the plants that were dusted or sprayed with copper fungicides and their leaves appeared to be somewhat dryer and abnormal. During the latter part of the season powdery mildew began to develop in the experimental plots and it was noted that it remained entirely absent from the sulfur plots.

As a whole, the season was successful from the experimental standpoint. It was concluded that the grower can expect the disease annually and that the plants should be sprayed or dusted as soon as possible after they are up, for the best control of the disease. It is not desirable to delay the applications after the first true leaf appears on the plants. The early applications prevent the primary infections and thus delay the secondary or general infection that usually is responsible for the death of the plants in this section. Copper-lime dust was the best dry fungicide; no detrimental effects were noted and on the other hand the plants remained free from the disease and of a healthy green color through the picking season.

EXPERIMENTS CONDUCTED DURING 1930

The general plan of the experiments for 1930 was similar to that of the previous season. Four individual experiments were placed on a cooperative basis at various points in the immediate vicinity of Gainesville. In addition to the yield as a measure of control, the general conditions of the plants in the various plots were compared and given rank according to the amount of green, yellow, and dead leaves on the plants in the plots.

Because of results of previous experiments only the fungicides which contain copper and sulfur were used in these experiments. The locations of the four experiments were carefully selected so as to include as wide a range of conditions as possible. The high lands are usually considered quite dry and crops growing on them often suffer during drouth. The low lands, on the other hand, are often wet and cold and seldom become dry enough to injure the plants growing upon them.

This season proved to be one of extremes as far as these plots were concerned. The seed were planted during a cold, rainy period and in most instances failed to germinate. A second planting was necessary and in some instances a third was required to obtain a good stand of plants. Late frosts were also instrumental in delaying the growth. About the time the seedlings were in the cotyledon stage in a majority of the fields the rainy period closed but cool weather continued for several weeks. The advent of warm weather resulted in rapid development of the plants. However, the lack of precipitation resulted almost immediately in drouth conditions that gradually became worse, which caused considerable injury to the plants in unirrigated fields. The earliest plantings were made in the latter part of February and other plantings continued until the middle of March. The first diseased leaves were collected April 1 on plants in the vicinity of Gainesville from the early planting, although the disease had been prevalent and destructive in other nearby sections of the state for several weeks. The first application of fungicides was made on April 18 when the plants in the experimental plots averaged two true leaves.

Experiment 1:—The plots in this experiment consisted of a portion of a 15-acre field which was cleared during the previous season but was not cultivated that year. The soil was a sandy loam and sloped very little. The whole field was irrigated by an overhead sprinkler system supplied with water from a small creek by engine and force pump.

The first application of fungicides was made on April 18 when the cucumber seedlings were developing the second and third true leaves. The applications of fungicides were made a week apart for six weeks. The comparative rank of the plots in the field in relation to appearance was determined before any other data were compiled. This relative rank represented the general appearance of the plots at the end of the picking season, the plot showing the least disease was given the arbitrary rank of 90 percent and the others were given a proportionate rating, depending on their condition.

TABLE XXVII.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 1—1930.

Plot		Fungicide		Cost				
No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers	Rank
81	1/12 A	cop. carb.	21.5 lbs.	$3.22	$ .40	6	32.7	80
82	1/12 A	cop. stearate	9.5 lbs.	1.42	.40	6	46	70
83	1/12 A	2-4-50 bord.	29 gal.	.29	.58	6	44.5	60
84	1/12 A	cop. carb.	21 lbs.	3.15	.40	6	38.2	70
85	1/12 A	sulfur	19 lbs.	.57	.40	6	32	50
86	1/24 A	check					17.2	30
87	1/12 A	cop. stearate	12 lbs.	1.85	.40	6	43	85
88	1/12 A	copper-lime	20.5 lbs.	1.64	.40	6	36.5	90
89	1/12 A	2-4-50 bord.	28 gal.	.28	.56	6	32.7	80
90	1/12 A	sulfur	17.5 lbs.	.52	.40	6	26	50
91	1/12 A	cop. stearate	13 lbs.	1.85	.40	6	43.2	60
92	1/12 A	copper-lime	20 lbs.	1.60	.40	6	44.7	70
Results calculated on basis of one acre.								
3	1 A	cop. stearate	138 lbs.	21.21	4.80	6	528	70 +
2	1 A	copper-lime	243 lbs.	19.44	4.80	6	487.5	80
2	1 A	2-4-50 bord.	342 gal.	3.42	6.84	6	463.5	70
2	1 A	cop. carb.	255 lbs.	38.22	4.80	6	426	75
1	1 A	check					414	30
2	1 A	sulfur	219 lbs.	6.54	4.80	6	348	50

The data given in Table XXVII show that copper stearate dust was most effective in controlling the disease (because of the greatest yield), followed closely by copper-lime dust, 2-4-50 bordeaux spray, and copper carbonate dust. The check plots produced well and even exceeded the sulfur-dusted plots. The sulfur seemed to harden the plants to a considerable extent, thus slowing down the growth and showing no beneficial effect in control of the disease. During previous seasons it was observed that 4-4-50 bordeaux injured the plants to some extent but no similar injury was observed this season when 2-4-50 bordeaux was used. The copper-lime and copper stearate dusts, which gave very nearly the same results in plot yields, also cost about the same. The bordeaux spray cost less than half as much, while the copper carbonate dust costs were twice as much.

Experiment 2:—This experiment was located in a 10-acre field on high, sandy, unirrigated land. Because of the exceptionally dry season, the yields were low. Up to the end of the picking season the downy mildew disease was not common. A large number of plants were infected (a single spot on a single leaf) but the actual loss because of the disease was less than 1 percent. The general procedure for taking data was similar to that in the preceding experiment. Table XXVIII gives the data accumulated from the various plots.

TABLE XXVIII.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 2—1930.

Plot		Fungicide		Cost			
No.	Size	Kind	Total Amt.	Mat'l	Labor	No. Appl.	Yield Hampers
81	1/6 A	copper stearate	14.5 lbs.	$ 2.17	$ .80	6	10.7
82	1/6 A	copper-lime	22.2 lbs.	1.78	.80	6	10.2
83	1/6 A	check					10.2
84	1/6 A	cop. carbonate	18.5 lbs.	2.77	.80	6	9.3
85	1/6 A	sulfur	19 lbs.	.57	.80	6	7.5
86	1/6 A	2-4-50 bordeaux	32 gal.	.32	.64	6	6
Results calculated on basis of one acre.							
81	1 A	copper stearate	87 lbs.	$13.02	$4.80	6	64.5
82	1 A	copper-lime	133.5 lbs.	10.68	4.80	6	61.5
83	1 A	check					61.5
84	1 A	cop. carbonate	111 lbs.	16.62	4.80	6	56
85	1 A	sulfur	114 lbs.	3.42	4.80	6	45
86	1 A	2-4-50 bordeaux	192 gal.	1.92	3.84	6	36

These data show that the check plots produced more fruit than the plots sprayed with bordeaux mixture or dusted with copper carbonate or sulfur. Since the disease was not common in the field with the exception of a few leaf spots on the plants in the check plot, the difference in yield must be attributed to other factors.

Experiment 3:—This experimental plot was located in a portion of a small field on black, sandy loam which was relatively low and ordinarily wet land. Considerable difficulty was experienced in obtaining a good stand of plants because of the excessive moisture at planting time. The disease appeared late in this field which was abandoned early on account of growth of weeds. The disease probably had very little effect on yield because of its late occurrence.

TABLE XXIX.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 3—1930.

Plot		Fungicides		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
75	1/5 A	copper stearate	14 lbs.	$ 2.10	$ .80	5	19.5
76	1/5 A	cop. carbonate	21.5 lbs.	3.22	.80	5	16.7
77	1/5 A	check					21.7
78	1/5 A	2-4-50 bordeaux	39 gal.	.39	.78	5	25.5
79	1/5 A	sulfur	21.7 lbs.	.65	.80	5	28.1
80	1/5 A	copper-lime	21 lbs.	1.68	.80	5	34.2

Results calculated on basis of one acre.

80	1 A	copper-lime	105 lbs.	$ 8.40	$4.00	5	171.2
79	1 A	sulfur	108.7 lbs.	3.25	4.00	5	140.4
78	1 A	2-4-50 bordeaux	195 gal.	1.95	3.90	5	127.5
77	1 A	check					108.7
75	1 A	copper stearate	70 lbs.	10.50	4.00	5	97.5
76	1 A	cop. carbonate	107.5 lbs.	16.10	4.00	5	83.7

These data show very little other than that sulfur and possibly bordeaux did not show detrimental effects on production. The copper stearate and copper-lime plots remained green longer than the others, although the yield from the former plot was less than the check.

TABLE XXX.—EFFECT OF SPRAYING AND DUSTING CUCUMBERS FOR THE CONTROL OF DOWNY MILDEW AS DETERMINED BY THE INCREASE IN YIELD. EXPERIMENT 4.—1930.

Plot		Fungicide		Cost		No. Appl.	Yield Hampers
No.	Size	Kind	Total Amt.	Mat'l	Labor		
62	1/5 A	copper-lime	22 lbs.	$ 1.76	$ .80	5	14
63	1/5 A	sulfur	22.5 lbs.	.67	.80	5	8.5
64	1/5 A	check					9.5
65	1/5 A	copper stearate	15.5 lbs.	2.32	.80	5	13
66	1/5 A	2-4-50 bordeaux	35 gal.	.35	.70	5	9
67	1/5 A	cop. carbonate	21 lbs.	3.15	.80	5	13.5

Results calculated on basis of one acre.

62	1 A	copper-lime	110 lbs.	$ 8.80	$4.00	5	70
67	1 A	cop. carbonate	105 lbs.	15.75	4.00	5	67.5
65	1 A	copper stearate	77.5 lbs.	11.60	4.00	5	65
64	1 A	check					49.5
66	1 A	2-4-50 bordeaux	175 gal.	1.75	3.50	5	45
63	1 A	sulfur	112.5 lbs.	3.35	4.00	5	42.5

Experiment 4:—This experiment was located on a relatively level piece of low unirrigated, sandy-loam soil. The early planting was injured by frost but the second planting developed quite uniformly. As previously stated, the first application of fungicide was made when the plants were in the 2-3 leaf stage. The disease appeared on the check rows about the time picking was begun and spread rapidly. By the end of the season they were entirely dead and the other plants in the field were more or less spotted regardless of the fungicidal applications.

The plots treated with copper fungicides, except bordeaux mixture, produced better than the check plot and they showed relatively less of the disease. The sulfur plot was not as good as the check plot in yield or in general appearance. This difference in yield does not indicate the great difference in the condition of the leaves and vines that was apparent. The plants in the plot sprayed with bordeaux showed the best green color of any plants of the various plots, although the yield was much lower than the check plot. In comparison the plants in the check plot at this time were almost completely dead.

Summary for Season 1930: —Because of the variation in the results obtained from the different plots the data have been summarized in Table XXXI. The results from the four experiments have been averaged in a short table where the information obtained with different treatments can be easily compared, since all the averages are calculated on a one-acre basis.

TABLE XXXI.—SUMMARY AND CONSOLIDATION OF THE DATA OBTAINED IN EXPERIMENTS CONDUCTED DURING THE SEASON OF 1930 IN RELATION TO THE CONTROL OF THE DOWNY MILDEW OF CUCUMBERS.

Plot		Fungicide		Cost		
Repl.	Size	Kind	Total Amt.	Mat'l	Labor	Yield Hampers
6	1 A	copper stearate	108 lbs.	$16.20	$4.53	301.8
5	1 A	copper-lime	170 lbs.	13.60	4.53	255.5
5	1 A	2-4-50 bordeaux	249 gal.	2.49	4.98	227.1
5	1 A	cop. carbonate	166.7 lbs.	25.00	4.53	207.8
5	1 A	sulfur	154.6 lbs.	4.63	4.53	184.8
4	1 A	check				158.4

It may be observed from the above table that the plots dusted with copper stearate dust produced the most fruit, which is taken as direct evidence of the best control of the disease. The other fungicides are arranged in descending order according to yield. Sulfur appears to produce a general detrimental effect to cucumber plants in spite of slight fungicidal value. This condition was very consistent throughout the season and especially where downy mildew was present. In the above table the comparative yields show that the plots dusted with sulfur averaged only slightly more fruit than the check plots to which no fungicide was applied.

The yields of all plots this year were below the average, except the irrigated fields, because of the lack of rain during picking season. The costs of material and labor appear to be insignificant at first sight. However, certain of the fungicides cost so much that the added increase in yield does not cover the cost of the fungicide. This is especially true with copper carbonate in which the increase in yield cost 60 cents per hamper. Copper stearate costs as much per pound as copper carbonate but it is a much lighter dust and less is required per application. The increased yield resulting from its use cost 16½ cents per hamper. Copper-lime dust costs less than half as much as copper stearate or copper carbonate per pound and showed a high yield among the fungicides used during the season, the cost per hamper for the increased yield being 18½ cents. Thus, considering both cost and control, it gave the best control of downy mildew.

DISCUSSION AND SUMMARY

During the period from 1925 to 1930 inclusive, downy mildew was an important factor in the production of cucumbers in the vicinity of Gainesville, Florida. The first applications of the fungicides were usually made during the first half of April. At the time of the first application the plants were usually small, generally showing only two or three true leaves. The application of the fungicides was delayed during one of the seasons, until the plants showed their first blossoms and it was found that the treated plots showed almost as much disease as the check plots with little or no increase in yield and with additional expense of the fungicides and their application. The indications are that the first applications of the fungicides should be made as soon as the first true leaves develop and should be frequent enough thereafter to keep the plant well covered. A series of experiments were conducted in which the number of applications was varied, the single applications being made early. The data show that in general the greater the number of applications of the fungicide the better the yield.

In all experimental plots during the six years the disease appeared in the check plots first and gradually spread to the others. Only under conditions favorable for the development of the fungus was it difficult to obtain a satisfactory commercial control of the disease.

The disease may appear in cucumber fields at any time after true leaves have developed, averaging usually three to four weeks later, however. During the extremely early season of 1929 in which the plants were at least two weeks ahead of the average seasons, the disease first appeared March 30, approximately a month earlier than it appeared during the late season of 1927. The appearance of the disease has occurred usually during the first half of April, at which time the first applications of fungicides were made. The disease appears first on the oldest, furthest developed plants and, if the plants in a field are all the same age, the disease most often appears first on the most vigorous growing plants. In certain fields during different seasons these thrifty plants may be in wet or dry places or on the southern exposure of hills or in places protected on the north by woods. There has been no consistency in the first appearance of the disease in a definite place or field year after year.

There are other factors of importance that should be mentioned in relation to the successful growing of cucumbers, such as crop competition with other cucumber-growing sections and the direct effect of a fluctuating market. Indirectly, these agencies are more or less connected and have a direct bearing on total production in this section because the fruits are not picked when they cannot be sold profitably. During ordinary seasons, when only the disease is a factor in production, the picking season continues for about a month. When crop competition and market prices are to be considered, the picking season may be limited to a week or 10 days. Late killing frosts are probably more responsible for crop competition that affects this section than any other single factor or condition.

The experiments concerning the possible control of the disease have been conducted over a period of six years during which time a number of fungicides have been used. Some of the fungicides were discontinued after a season or more because they proved to be no better than the more common ones and their use by the growers was considered impractical since they were too expensive and the advantage negligible or that they were detrimental to the development of the plant that was not affected by the disease.

The seasons vary considerably in relation to earliness, growing conditions, appearance and prevalence of the disease, competition and market prices, length of season, and total yield. These factors have been taken into consideration wherever possible and the data collected and herein summarized have been accumulated under these conditions. Table XXXII shows a summary of the final tables of each of the six seasons, all of which have been computed on an acre basis for comparison. The table contains the number of replications over the entire period, also the kinds of fungicides used, with average amounts and costs and the average yields in hampers.

TABLE XXXII.—SUMMARY OF THE DATA OBTAINED IN EXPERIMENTS CONDUCTED DURING THE SUCCESSIVE SEASONS FROM 1925-1930 INCLUSIVE IN RELATION TO THE CONTROL OF DOWNY MILDEW OF CUCUMBERS.

Plot		Fungicide		Cost		Yield Hampers
Repl.	Size	Kind	Total Amt.	Mat'l	Labor	
15	1 A	copper stearate	94 lbs.	$14.86	$4.28	303.2
45	1 A	2-4-50 bordeaux	223.1 gal.	2.14	4.29	297
45	1 A	copper-lime	176.8 lbs.	15.36	3.27	294.7
47	1 A	check				258
14	1 A	cop. carbonate	173.6 lbs.	27.69	4.38	247.2
16	1 A	sulfur	206.5 lbs.	6.38	3.71	206.3

The yield of the different plots in each experiment was taken as a unit of measure of the effectiveness of the fungicides in the control of the disease, the premise being that the more prevalent and severe the disease the more the yield is reduced. The most effective fungicide was copper stearate dust. The cost per hamper of the increased yield resulting from the use of copper stearate was 42 cents. Bordeaux mixture, 2-4-50, prepared with hydrated lime, gave almost as good control as copper stearate at a cost per hamper of 16½ cents for the increased yield. The data in this table are the average of 45 replications over the six-year period. It was found that hydrated lime used in place of rock lime in the preparation of bordeaux mixture gave as good results and was cheaper, more available, and easier to handle and store. Calcium caseinate was used in the sprays for cucumbers one season but was discontinued because no advantage was discovered. In comparison with the check plots, of which there were 47 replications during the period, the data show that the plots sprayed with bordeaux produced 14 percent more fruit. The plots treated with copper-lime dust ranked second in yield, averaging 13 percent more fruit than the check plots. It may also be seen that the yield of plots sprayed with bordeaux was only 1 percent greater than that from plots treated with copper-lime dust, when the average of the same number of replications is considered.

It should be noted that the average cost of material and labor for the applications of copper-lime dust amounted to $18.63 per acre, or 50⅔ cents per hamper for the increase in yield, while the added cost of the bordeaux spray was only $6.43 per acre or 16½ cents per hamper for the increased yield. Thus, both bordeaux spray and copper-lime dust proved to be profitable when the increased yield is considered with added costs. The other fungicides listed in the table were not profitable and do not warrant further discussion.

CONCLUSIONS

1. The first applications of fungicides to cucumber plants should be made as soon as the true leaves appear.

2. Five applications of fungicide controlled downy mildew better than fewer applications.

3. The disease usually appeared first on the oldest and most developed plants.

4. Hydrated lime proved to be a good substitute for rock lime in preparing bordeaux mixture; the amount used was increased one-half by weight.

5. Calcium caseinate, a commercial form of which is sold as Kayso, did not prove beneficial in bordeaux mixture applied to cucumber plants.

6. Cucumber plants sprayed with bordeaux mixture produced 14 percent more fruit during the picking season over a six-year period than non-sprayed plants.

7. Cucumber plants dusted with copper-lime dust produced 13 percent more fruit during the picking season over a six-year period than non-dusted plants.

8. Sulfur in various forms used was detrimental to the development of cucumber plants.

9. Bordeaux mixture (2-4-50) was the cheapest and, except for copper carbonate and copper stearate, most beneficial of the fungicides used.

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FLORIDA TRUCK CROP COMPETITION

II. Intra-State

By JOHN L. WANN

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FLORIDA TRUCK CROP[1] COMPETITION[2]

II. Intra-State

By JOHN L. WANN

INTRODUCTION

Florida Bulletin 224, Florida Truck Crop Competition, is a study of the competition of Florida with other states and foreign countries in the marketing of truck crops. This bulletin is a continuation of the above study, but is confined to the State of Florida.

PURPOSE OF THE STUDY

The purpose of this study is to learn how Florida trucking areas compete among themselves, to determine the degree of keenness of that intra-state competition, and to attempt to designate the production areas for each crop. Also, it is hoped to see whether the competition can be decreased, in some cases, by earlier or later planting as the case may be, thus permitting the shipment of a greater total number of cars but with lower peaks spread over a longer period of time.

METHOD OF GATHERING THE DATA

The data come from the three principal modes of transportation: freight, express and boat (Figs. 1 and 2).

To obtain the number of carloads shipped by freight, a count was made of the number of carloads of each commodity from the original conductors' waybills. These waybills are the records

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ACKNOWLEDGMENTS: Much credit is due the railway companies, the Railway Express Agency and the water transportation companies which furnished the data from their books and records and made this study possible.

This study was made under the direction of Drs. C. V. Noble and J. E. Turlington. Mr. Marvin A. Brooker, Mr. Bruce McKinley and Dr. C. V. Noble assisted in the field work. Mr. H. A. Marks, Agricultural Statistician, United States Department of Agriculture, helped determine the areas for each commodity. To these and to any other persons who assisted in the preparation of this work, the writer expresses his thanks.

[1] This study also includes some fruit crops other than citrus.

[2] This is in substance a thesis prepared to meet in part the requirements of the Graduate Council of the University of Florida for the degree of Master of Science in Agriculture.

kept and turned in by the conductor when he returns to his headquarters from his trip into the state to get his trainload of freight.

All express points in the state were visited where, in the opinion of the officials of the Railway Express Agency, there was movement of any quantity of truck crops by this mode. The express data are an actual count of each hamper or other container of each commodity recorded on the express waybill by the express agent when the commodity was shipped from his station. Data were obtained from 306 shipping points (Fig. 2). Several shipping points have two express offices.

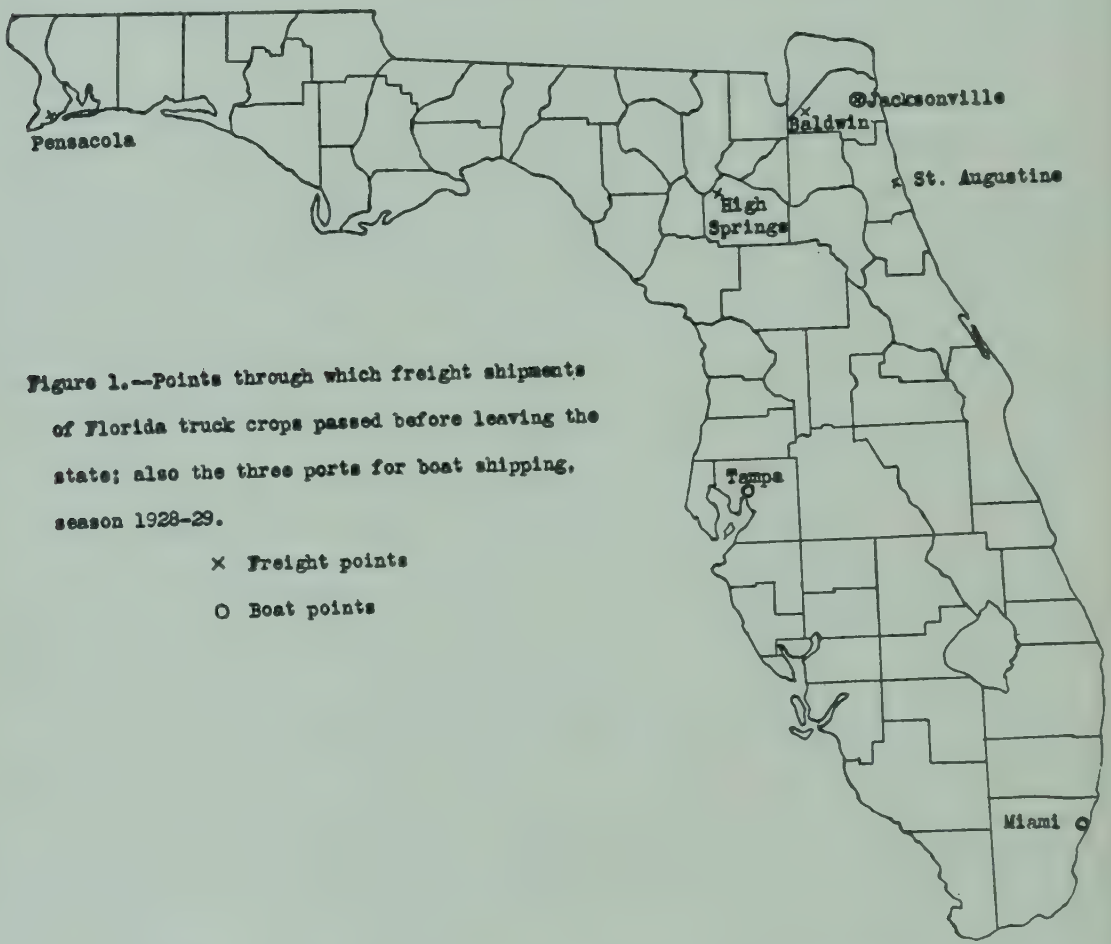

Figure 1.—Points through which freight shipments of Florida truck crops passed before leaving the state; also the three ports for boat shipping, season 1928-29.

Boat shipments of Florida truck crops moved from the state at three points, viz. Jacksonville, Miami and Tampa. The boat captain keeps a record similar to that of the freight conductor. The data herein were obtained either from the reports of boat captains or from the books of the various ship companies.

The crates, hampers, or other containers of the express and boat shipments were converted to equivalent carloads. Equivalent carloads mean the average number of crates, hampers, or other containers in a car. This was actually determined for 13 commodities as shown in Table I in the appendix. For other commodities the estimates of railroad officials who work with these shipments from day to day were accepted.

The data for this study are for the year September 1, 1928 to August 31, 1929, inclusive.

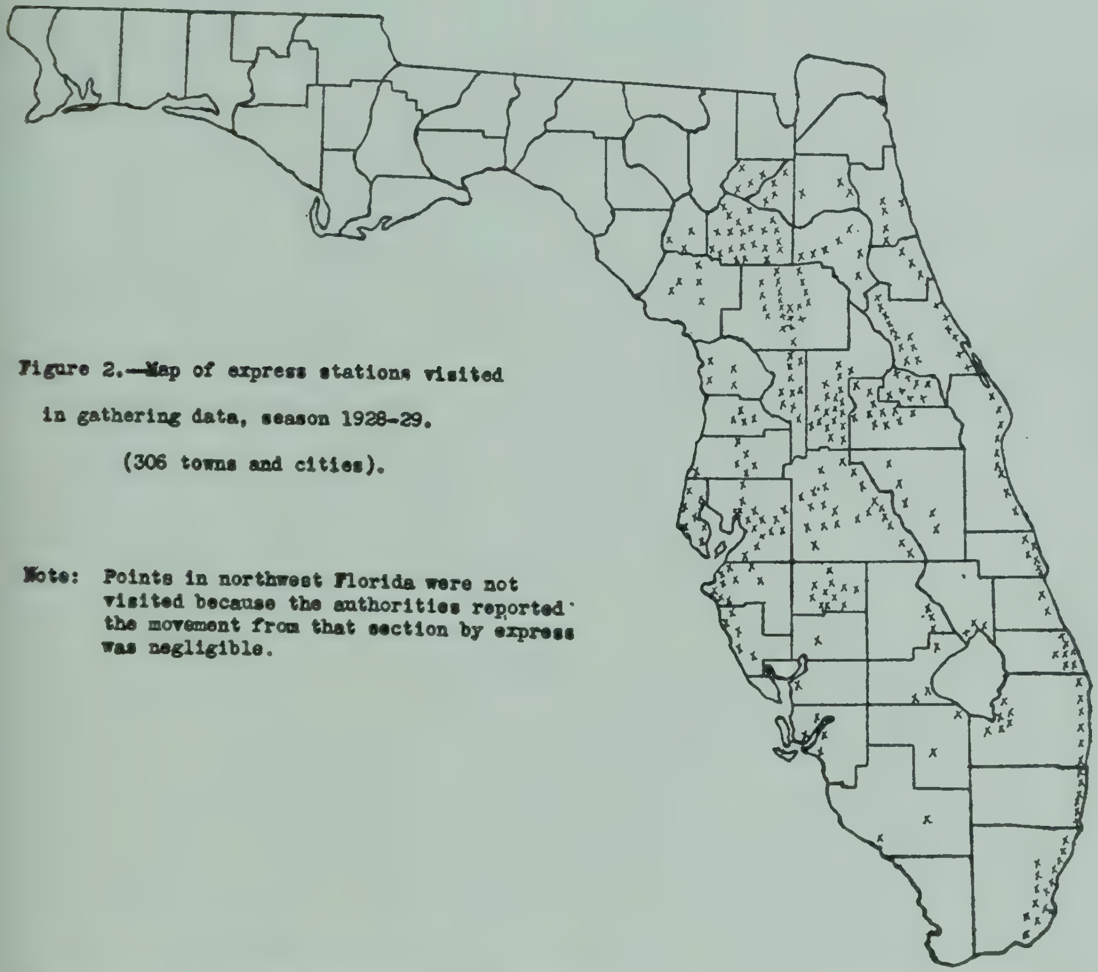

Figure 2.—Map of express stations visited in gathering data, season 1928-29. (306 towns and cities).

Note: Points in northwest Florida were not visited because the authorities reported the movement from that section by express was negligible.

In 1929 Florida shipped 12,465 mixed carloads of fruits and vegetables, of which 2,978 were vegetables and the rest were citrus[3]. The freight records do not show the names of the commodities contained in these mixed cars.

No attempt was made to ascertain the amount of these crops that is moved by auto trucks, nor of the amount consumed within the state.

METHODS OF SHIPPING TO MARKET

A total of 50,705.3 equivalent carloads of truck crops went out of the state during the 1928-29 season, as shown in Table LX.

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[3] United States Department of Agriculture. Shipping Fruits and Vegetables in Mixed Carloads. Report for August 1930. (Mimeographed.)

Of this grand total, 1,871 carloads, or 3.7 percent, went by boat, 4,037 carloads, or 8 percent, went by express, and 44,792 carloads, or 88.3 percent, went by freight. (Table I.)

TABLE I.—QUANTITIES AND PERCENTAGES OF FLORIDA TRUCK CROPS SHIPPED BY DIFFERENT METHODS, SEASON 1928-29.*

Crop	EQUIVALENT CARLOADS			PERCENT OF TOTAL SHIPPED		
	By Freight	By Express	By Boat	By Freight	By Express	By Boat
Watermelons	9,960	....	....	100	....	....
Celery	8,731	17	2	99.8	.2	†
Tomatoes	7,169	241	845	86.9	2.9	10.2
Green Beans	3,116	2,043	133	58.9	38.6	2.5
Early White Potatoes	4,907	14	342	93.2	.3	6.5
Cabbage	3,034	5	134	95.6	.2	4.2
Cucumbers	2,159	145	4	93.5	6.3	.2
Peppers	1,613	329	357	70.2	14.3	15.5
Strawberries	1,620	524	1	75.5	24.4	.1
Lettuce	902	34	....	96.4	3.6	....
Escarole	675	1	....	99.9	.1	....
Eggplants	202	116	11	61.4	35.3	3.3
Romaine	290	3	....	99	1	....
Green Corn	272	21	....	92.8	7.2	....
Squashes	22	179	35	9.3	75.9	14.8
Okra	....	227	....	....	100	....
Green Peas	31	85	3	26.1	71.4	2.5

---

*Crops shipped in less than 100 carloads per year omitted, also fractional carloads omitted.

†Weekly shipments of less than .1 carload omitted.

Of the nine major crops green beans, peppers and strawberries figured high in the movement by express, while the percentage of tomatoes, peppers and early white potatoes going by boat was rather high.

It is to be expected that these percentages vary for many of these crops for different years. It was said by express agents, for example, that the proportion of strawberries moving by express is often greater than for the year in question. Volume and price of the commodity determine, more than any other factors, the method of shipment to be used.

COMPETITION DEFINED

There are many things which have a bearing on competition. Among them are market demand, season of production, price, destination, different types of the same crop, number of areas, competition from other commodities, number of pickings, time of shipment and competition from other states and imports.

Since all the above factors have a bearing on competition, the following is a very broad definition of the term: There is competition when one unit of a commodity is prevented from selling for what it would have sold had not the second unit been produced.

METHODS OF PRESENTATION

For the purpose of better presentation of these data the 51 truck crops (including some fruits) have been divided into major, sub-major, minor, and miscellaneous crops. The basis for this classification is the car-lot shipments from the state for the season 1928-29, and not the value of the commodities.

Since volume was the first consideration, the commodities are discussed in the order of their equivalent car-lot movement. The first nine crops fall naturally into one group because they are of major importance in the state. There was a difference of 1,208.9 equivalent carloads between strawberries, the crop with the smallest volume in the major group, and lettuce, the crop with the largest volume in the sub-major group. No doubt lettuce, escarole, eggplant, and some of the other sub-major crops are

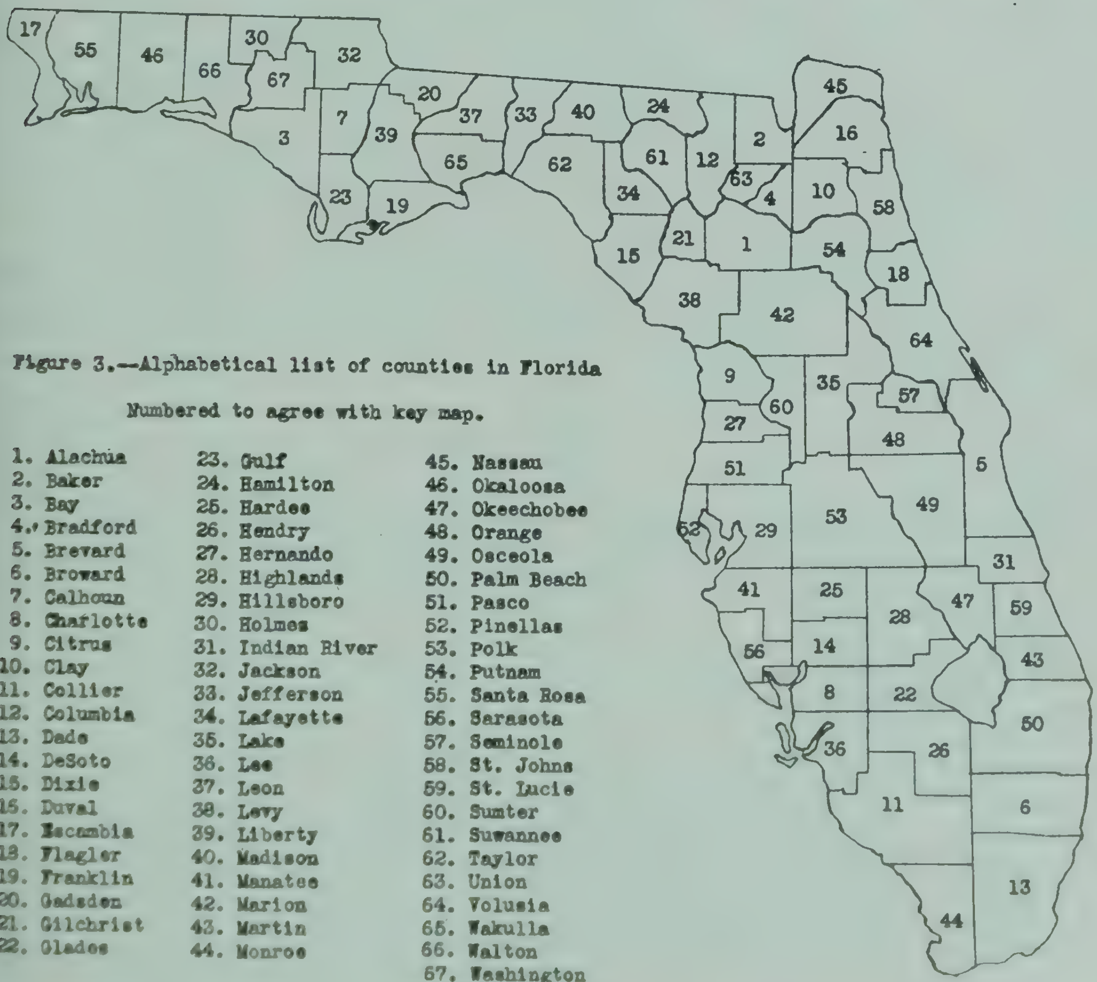

Figure 3.—Alphabetical list of counties in Florida

Numbered to agree with key map.

1. Alachua
2. Baker
3. Bay
4. Bradford
5. Brevard
6. Broward
7. Calhoun
8. Charlotte
9. Citrus
10. Clay
11. Collier
12. Columbia
13. Dade
14. DeSoto
15. Dixie
16. Duval
17. Escambia
18. Flagler
19. Franklin
20. Gadsden
21. Gilchrist
22. Glades
23. Gulf
24. Hamilton
25. Hardee
26. Hendry
27. Hernando
28. Highlands
29. Hillsboro
30. Holmes
31. Indian River
32. Jackson
33. Jefferson
34. Lafayette
35. Lake
36. Lee
37. Leon
38. Levy
39. Liberty
40. Madison
41. Manatee
42. Marion
43. Martin
44. Monroe
45. Nassau
46. Okaloosa
47. Okeechobee
48. Orange
49. Osceola
50. Palm Beach
51. Pasco
52. Pinellas
53. Polk
54. Putnam
55. Santa Rosa
56. Sarasota
57. Seminole
58. St. Johns
59. St. Lucie
60. Sumter
61. Suwannee
62. Taylor
63. Union
64. Volusia
65. Wakulla
66. Walton
67. Washington

of major importance in certain local sections of the state, but it has been found convenient to place in the sub-major group all those crops of which between 100 and 1,000 carloads were shipped during the year. All crops of which from 10 to 100 carloads were shipped were placed in the minor crops group, and those under 10 carloads were considered in the miscellaneous group.

Data for the major and sub-major crops have been presented in four ways: the text, tables showing weekly summaries of equivalent car-lot shipments of each commodity for the year, tables showing the weekly summary of equivalent car-lot shipments of each commodity by areas for the year, and maps of Florida showing equivalent car lots of each commodity by counties and areas. The minor and miscellaneous crops have been presented by means of text, and tables showing the weekly summary of equivalent car-lot shipments of each commodity for the year. The principal factors considered in determining the production areas for the different truck crops were: Time of shipment; geographic location; methods of production as influenced by type of soil, topography, drainage, land values, etc.; and advice of growers, shippers and others directly interested in the truck crop industry of Florida. It was not deemed feasible to cross county boundaries in designating areas. The areas were numbered in the order in which their first shipment was made.

For the convenience of the reader who may not be entirely familiar with the counties of Florida, a key map of the state has been included. (Fig. 3.)

MAJOR CROPS

TABLE II.—TOTAL EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA MAJOR TRUCK CROPS, SEASON 1928-1929.

Crop	Equivalent Carloads
Watermelons	9,960.2
Celery	8,749.8
Tomatoes	8,255.4
Green Beans	5,291.7
Early White Potatoes	5,262.5
Cabbage	3,173.1
Cucumbers	2,307.5
Peppers	2,299.3
Strawberries	2,144.8

WATERMELONS

During the season of 1929 Florida shipped 9,960.2 equivalent carloads of watermelons (Table III). The first cars moved from the state that year near the middle of April. Within the state there are at least four important areas (Table IV), as shown in Fig. 4, and they do compete. The extreme southern area, including all counties south of Polk County and designated as Area 1, came on the market first during the week ending April 20 with 5 carloads. The peak for that area occurred May 11 (Table IV) when 85.2 carloads were shipped. This area had no competition from other states, and imports were negligible[4]. This suggests a possible opening for a slight increased production in this area during March, April and early May. There is the possibility that the publc may be taught to consume more watermelons in cool weather, as has been done with ice cream.

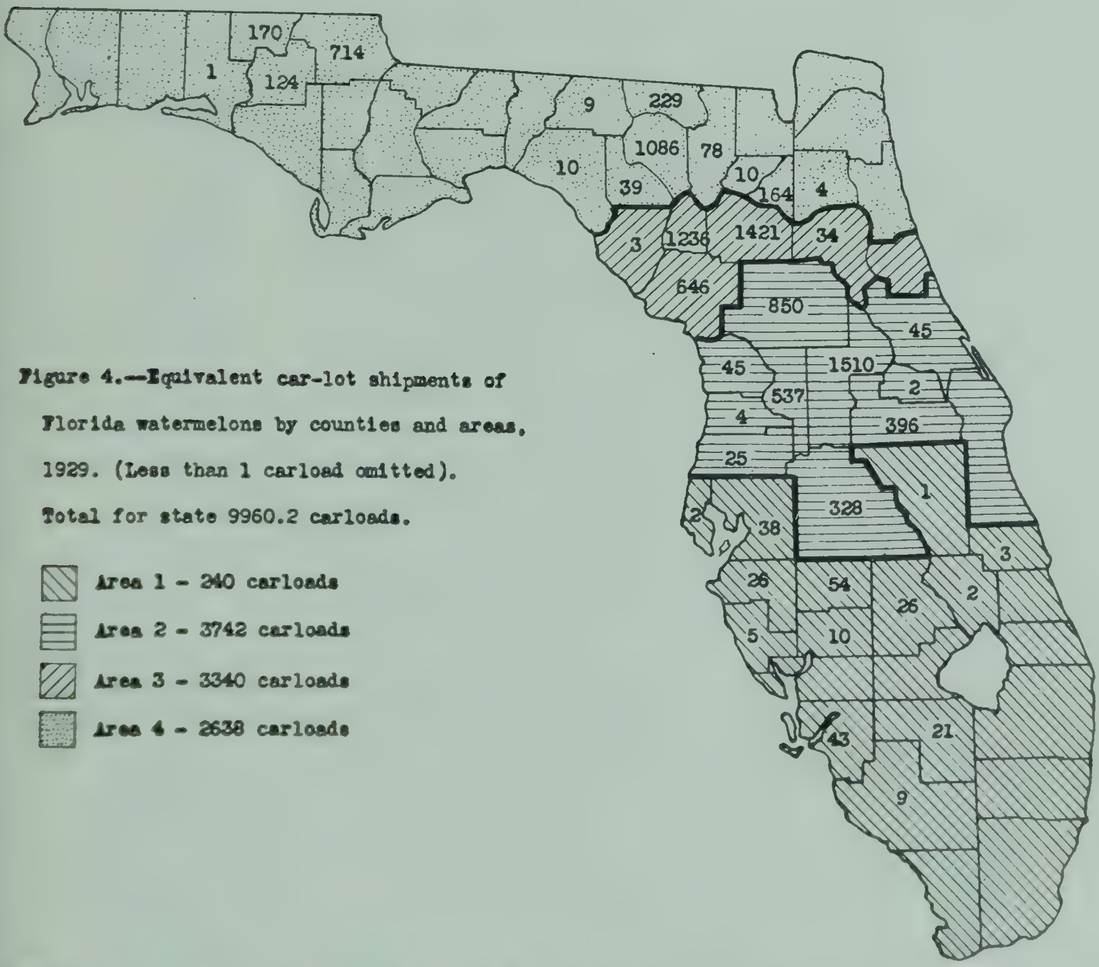

Figure 4.—Equivalent car-lot shipments of Florida watermelons by counties and areas, 1929. (Less than 1 carload omitted). Total for state 9960.2 carloads.

▧ Area 1 - 240 carloads
▤ Area 2 - 3742 carloads
▨ Area 3 - 3340 carloads
░ Area 4 - 2638 carloads

The next area to ship was Area 2 (including Marion, Sumter, Orange, Polk and Lake counties) which started the week end-

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[4] Noble, C. V., and Marvin A. Brooker. Florida Truck Crop Competition. Fla. Agri. Exp. Sta. Bul. 224: 1931.

TABLE III.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA WATERMELONS BY COUNTIES, 1929*

Weeks Ending		Hendry	Lee	Collier	De Soto	Hardee	Highlands	Hillsborough	Indian River	Lake	Manatee	Polk	Alachua	Dade
April	20	3	2	....	....	....	....	....	....	....	....	....	....	....
	27	13	8	....	....	....	....	....	....	....	....	....	....	....
May	4	3	14	5	4	5	7	6	1	17	3	9	....	....
	11	1	17	4	2	23	11	12	2	67	10	56	1	.2
	18	1	1	....	3	11	6	8	....	267	6	80	1	....
	25	....	1	....	....	7	2	7	....	362	6	60	11	....
June	1	....	....	....	....	6	....	3	....	494	1	59	368	....
	8	....	....	....	....	2	....	2	....	225	....	46	664	....
	15	....	....	....	....	....	....	....	....	70	....	18	311	....
	22	....	....	....	1	....	....	....	....	8	....	....	59	....
	29	....	....	....	....	....	....	....	....	....	....	....	5	....
July	6	....	....	....	....	....	....	....	....	....	....	....	1	....
	13	....	....	....	....	....	....	....	....	....	....	....	....	....
Total		21	43	9	10	54	26	38	3	1510	26	328	1421	.2

*Weekly shipments of less than .1 carload omitted.

TABLE III.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA WATERMELONS BY COUNTIES, 1929*—Continued.

Weeks Ending	Marion	Orange	Pasco	Sarasota	Sumter	Citrus	Pinellas	Levy	Okeechobee	Seminole	Volusia	Bradford	Gilchrist	Hernando	Putnam
April 20															
27															
May 4															
11	1	4	4	3	6										
18	25	31	5	2	105	1	2								
25	139	83	6		195	6		4	1	2	1				
June 1	328	161	4		156	19		150	1		20	3	219	2	3
8	275	76	6		73	16		328			16	64	684	2	22
15	63	40			2	2		148			7	75	312		9
22	16	1				1		16			1	20	21		
29	2											2			
July 6	1														
13															
Total	850	396	25	5	537	45	2	646	2	2	45	164	1236	4	34

*Weekly shipments of less than .1 carload omitted.

TABLE III.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA WATERMELONS BY COUNTIES, 1929*—Continued.

Weeks Ending	Suwannee	Columbia	Dixie	Hamilton	Jackson	Lafayette	Madison	Osceola	Union	Walton	Clay	Holmes	Taylor	Washington	Total
April 20	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5
27	....	....	....	....	....	....	....	....	....	....	....	....	....	....	21
May 4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	74
11	....	....	....	....	....	....	....	....	....	....	....	....	....	....	224.2
18	....	....	....	....	....	....	....	....	....	....	....	....	....	....	555
25	....	....	....	....	....	....	....	....	....	....	....	....	....	....	893
June 1	2	....	....	....	....	....	....	....	....	....	....	....	....	....	1999
8	75	7	2	9	3	3	1	1	5	1	....	....	....	....	2608
15	311	15	1	59	60	10	3	....	3	....	3	5	4	12	1543
22	415	50	....	93	406	18	....	....	....	....	1	94	6	74	1301
29	264	3	....	62	220	5	5	....	2	....	....	64	....	29	663
July 6	18	3	....	5	21	3	....	....	....	....	....	7	....	6	65
13	1	....	....	1	4	....	....	....	....	....	....	....	....	3	9
Total...	1086	78	3	229	714	39	9	1	10·	1	4	170	10	124	9960.2

*Weekly shipments of less than .1 carload omitted.

TABLE IV.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA WATERMELONS BY AREAS, 1929.*

Weeks Ending	Area 1†	Area 2†	Area 3†	Area 4†	Total
April 20	5	....	....	....	5
27	21	....	....	....	21
May 4	48	26	....	....	74
11	85.2	138	1	....	224.2
18	40	514	1	....	555
25	24	854	15	....	893
June 1	11	1,243	740	5	1,999
8	5	735	1,700	168	2,608
15	....	202	781	560	1,543
22	1	27	96	1,177	1,301
29	....	2	5	656	663
July 6	....	1	1	63	65
13	....	....	....	9	9
Total	240.2	3,742	3,340	2,638	9,960.2

*Weekly shipments of less than .1 carload omitted.
†See Fig. 4 for counties included.

ing May 4; then came Area 3 (including Alachua, Gilchrist, and Levy counties) the week ending May 11; and the week of June 1 Area 4 (all counties north of Alachua, also West Florida) started shipping. The peak for Area 2 was June 1 with 1,243 carloads. The peak for Area 3 occurred the following week. Two weeks later, June 22, Area 4 had its peak and shipped 1,177 carloads. The total shipments from all areas during the heaviest week, June 8, was 2,608 carloads. It would seem very probable that keen competition occurs within the state itself, especially since some of the areas ship their highest amount only one and two weeks apart. It is true that later in the summer when the weather is warmer a much larger weekly volume of watermelons goes on the markets and is sold and consumed, but at a price at which Florida cannot compete with states farther north.

CELERY

Florida shipped 8,749.8 carloads of celery during the season 1928-29 (Table II). Unlike watermelons, which were shipped from several counties, the bulk of celery moved from only three counties—Manatee, Sarasota and Seminole. In fact 73.6 percent of the total carloads from the state originated in Seminole County. There are two distinct areas growing celery (Fig. 5).

TABLE V.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA CELERY BY COUNTIES, SEASON 1928-29.*

Weeks Ending	Sarasota	Manatee	Seminole	Hillsborough	Orange	Putnam	St. Johns	Clay	Highlands	Lake	Polk	Marion	Palm Beach	Brevard	Total
Dec. 29	.2														.2
Jan. 5															
12	3.1	6	2												11.1
19	43.4	34.2	55.3	.3											133.2
26	16.6	79.2	157.1		.1	5	1								259
Feb. 2	40.2	108.1	229.5			2	9								388.8
9	45.1	109.2	293.4			3									450.7
16	43.3	119.1	450.6		.1	5									618.1
23	40.2	80.2	584.4		1	2	1	.1							708.9
Mar. 2	45.2	57.1	563.5	1	1.1	4.1	10		1						683
9	16.1	34.1	592.8		4	3	2		1						653
16	8	30.1	18.2			1	4								61.3
23	30.1	53.3	845.3		6	1.1				1					936.8
30	17	30.1	695.4		6	5			3	1					757.5
Apr. 6	1	40	501.6			4	1		1	1					549.6
13	9	122.1	486.4	.7	4	3					1				626.2
20	12.1	98.1	265.5		6	1					1				383.7
27	42.3	57.1	189.5		5	.2						1	1		296.1
May 4	147	78.2	182.2		10								2	11	430.4
11	168.2	56.2	132.3		8	1.1								4	369.8
18	132.2	15.1	44		11	2							2	3	209.3
25	19	1	109		3	1			2						135
June 1	15	1	29		1									8	54
8	8	.1	10			1								2	21.1
15			1			1								4	6
22			2			2									4
29						3									3
Total	902.3	1,209.6	6,440	2	66.3	50.5	28	.1	8	3	2	1	5	32	8,749.8

*Weekly shipments of less than .1 carload omitted.

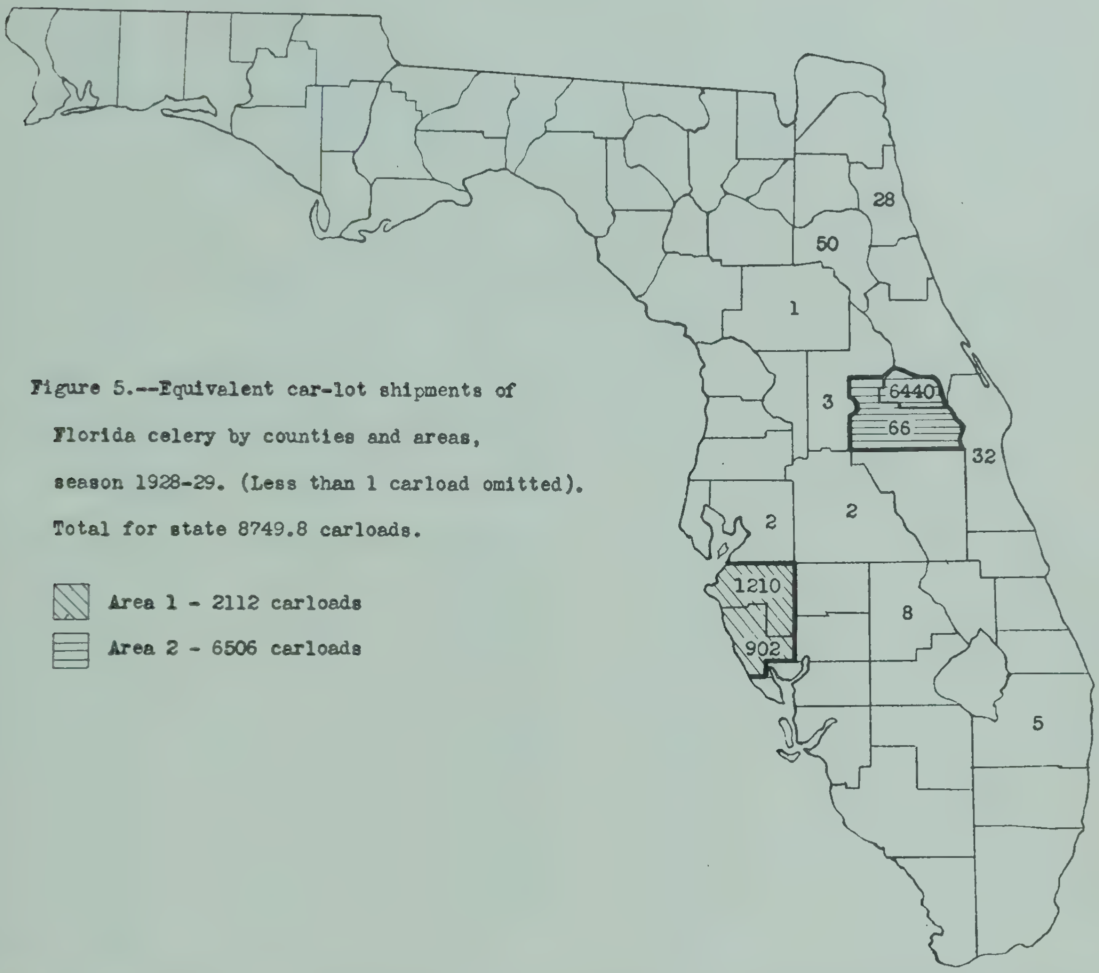

Figure 5.--Equivalent car-lot shipments of Florida celery by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 8749.8 carloads.

▧ Area 1 - 2112 carloads

▤ Area 2 - 6506 carloads

They are the Manatee-Sarasota and the Seminole-Orange Areas. Another district which is comparatively new could be designated as a separate area if it shipped larger amounts. It is Brevard County. This district is unique in that during the time of this study it put its entire product on the market late, after the first of May. The growers there evidently planned to grow celery to market after Seminole County had nearly finished (Table V). They encountered direct competition with the second peak of the Manatee-Sarasota area. It appears that the Manatee-Sarasota area manipulated its production so as to have two peaks which were quite wide apart as to time on the market, and thus they partly missed the strong competition from Area 2 which had several weeks of rather heavy shipments (Table VI). The low shipments shown for the week of March 16 from Area 2 were due to a voluntary abatement of shipping on the part of the dealers and growers for the purpose of improving the price.

TABLE VI.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA CELERY BY AREAS, SEASON 1928-29.*

Weeks Ending		Area 1†	Area 2†	Other Counties†	Total
Dec.	29	.2			.2
Jan.	5				
	12	9.1	2		11.1
	19	77.6	55.3	.3	133.2
	26	95.8	157.2	6	259
Feb.	2	148.3	229.5	11	388.8
	9	154.3	293.4	3	450.7
	16	162.4	450.7	5	618.1
	23	120.4	585.4	3.1	708.9
Mar.	2	102.3	564.6	16.1	683
	9	50.2	596.8	6	653
	16	38.1	18.2	5	61.3
	23	83.4	851.3	2.1	936.8
	30	47.1	701.4	9	757.5
Apr.	6	41	501.6	7	549.6
	13	131.1	490.4	4.7	626.2
	20	110.2	271.5	2	383.7
	27	99.4	194.5	2.2	296.1
May	4	225.2	192.2	13	430.4
	11	224.4	140.3	5.1	369.8
	18	147.3	55	7	209.3
	25	20	112	3	135
June	1	16	30	8	54
	8	8.1	10	3	21.1
	15		1	5	6
	22		2	2	4
	29			3	3
Total		2,111.9	6,506.3	131.6	8,749.8

*Weekly shipments of less than .1 carload omitted.
†See Fig. 5 for counties included.

TOMATOES

A total of 8,255.4 equivalent carloads of tomatoes were shipped from Florida during the season 1928-29. Tomatoes are grown for market over most of the state south of Union County (Fig. 6), and they can be produced around Homestead in Dade County continuously from early November to the end of May (Table VII). The state has been divided into three large tomato producing areas (Fig. 6). Eleven southern counties constitute Area 1. This area produced 5,181.8 carloads of tomatoes in 1928-29, and had an extremely long season.

TABLE VII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA TOMATOES BY COUNTIES, SEASON 1928-29.*

Weeks Ending		Dade	Lee	Broward	Orange	Volusia	Monroe	Seminole	Collier	Palm Beach	Pasco	Hardee	Indian River	Manatee	Glades	Martin	Okeechobee	Charlotte	St. Lucie
Nov.	3	.3																	
	10	10.8																	
	17	40.2																	
	24	37.5	.1																
Dec.	1	57.8	2	.1	3	1													
	8	72.1	1.7	.1			1	.1											
	15	117.8	5	5.1			1		1	.1	.1								
	22	95.9	6.7	6.3			1		3.1			.1							
	29	56.4	8.8	6.1			1		1.1				1						
Jan.	5	68.3	5.8	9.6			2	1	5.2	.2				.1					
	12	60.4	10.9	4.4			3	1	2.6	.3		.1	.1	.2	.2	.3	1		
	19	131.6	7.3	12.6			6		3.4	1.9			2.2	.1		1.3		1	
	26	123.2	8.7	11.5			3		1.3	1.9			3	.3		1.7		1.1	.1
Feb.	2	171.3	7.7	14			3		3.1	2.9			4.1			6.7			1.2
	9	209.2	4.3	6.9			4		2.1	5.6			1.3			6.4			.3
	16	265.1	4.1	15.7			3		1.2	5.2			.2			8.4			1.3
	23	304.7	5.2	16.9		1	1		3.4	12.6			.3			16.7			.5
Mar.	2	294.5	1.2	14.5			1		4.4	8.6			.1			12.6			1.2
	9	266.6	.4	17.9					9.2	11			.4			6.5			.1
	16	340.1	.2	30.1					15.1	11.7			.2			5.3	.1		3.1
	23	300.1	.2	37.1					24	9.5			.6			1.1	.4		.2
	30	287.6	.5	60.8					46	8.5			.3		.3	.2	.5	.1	.2
Apr.	6	165.3	.3	50					19	7.8		.1	12.1	2.1	.1	2.1	.4	1.1	1.6
	13	107.9	1.9	61					16	6.5		5.3	44.3	36.1	.2	1.1	2.1	2	12.4
	20	119.6	1.1	54.5		1			7	19.1		18.7	101.5	187.7	.1	1.1	4.4	3	33.5
	27	58	1.6	31	1	.3		1.1	14.1	14.1	.1	32.6	91.5	345.2	2.1	1.3	9.3	3.2	43.3
May	4	32	.3	27.2	2			.3	12	36.5	.1	34.8	67.6	332	1.1	1	23.1	3.1	36
	11	13.8	.3	31.9		2.2		.8	8	41.7	.4	30.9	46.5	188.1	.1		36.3	.1	25
	18	7.7		14.5	3.1	1.5		.7		32.2	.4	16.2	24.6	40.3			23.1	1	5
	25	1.3		1.1	2.1	2.3		.1		8.6	.2	2.1	2.4	4.3			4		
June	1	.5			3	1.1				.2	.1	.3	.2	1.2					
	8				1	1.1					.1			1.1					
	15				1							.1	.1						
	22																		
	29																		
Total		3,817.6	86.3	540.9	16.2	11.5	30	5.1	202.3	246.7	1.5	141.3	404.6	1,138.8	4.2	73.8	104.7	15.7	165

*Weekly shipments of less than .1 carload omitted.

TABLE VII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA TOMATOES BY COUNTIES, SEASON 1928-29—Continued.*

Weeks Ending	Citrus	Polk	Brevard	Hendry	Hillsborough	Marion	Sarasota	Sumter	Lake	Bradford	Hernando	Levy	Osceola	Alachua	Clay	Union	Total
Nov. 3																	.3
10																	10.8
17																	40.2
24																	37.6
Dec. 1																	63.9
8																	75
15																	130.1
22																	113.1
29																	74.4
Jan. 5																	92.2
12																	84.5
19																	167.4
26																	155.8
Feb. 2	.1																214.1
9		.1															240.2
16			1														305.2
23			.1														362.4
Mar. 2																	338.1
9			.3														312.4
16			.1														406
23			1.4	.1													374.7
30			.3		.1												405.4
Apr. 6			.2	.1	.1												262.4
13		.1	.1	1.1	2.5												300.6
20		.2	.3	4.5	8.9	.3	1	1.4									568.9
27		.4	.3	4.3	37.7	4		44.7	.1								741.3
May 4		1.9		13.4	54	32.7		90.4	1.1	.1	1	.1	.2				804
11		2.4	4.5	11.6	53	52.9	.1	108.3	2.1	.2	2	.3	1.2	.2	.1		665
18		3.6	5.3	16.6	39.8	104.9	.1	102.9	1.1	.4	3	.3	.1	1.2			449.6
25		.4	2	4.3	8	124.6		40.3	1.1	.1	1		1	1.3		2	214.6
June 1		1.5	1	3.3	3.7	89.9		22.1		.4	1	.1	1	3.7		1	135.3
8			1	.3	.2	56.5		9.3		.3	1		1	3.6		.2	76.7
15					.1	12.8		3.1		.6				4.6		.5	22.9
22						5.5		.2		.2				3.4		.2	9.5
29						.2				.1				.3		.2	.8
Total	.1	10.6	17.9	59.6	208.1	484.3	1.2	422.7	5.5	2.4	9	.8	4.5	18.3	.1	4.1	8,255.4

*Weekly shipments of less than .1 carload omitted.

Observation of the peaks discloses that Area 2 (including Alachua, Marion and Sumter counties) came on the market strongest after Areas 1 and 3 were dropping off, but Area 3, which includes Manatee and Indian River counties, came on the

TABLE VIII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA TOMATOES BY AREAS, SEASON 1928-29.*

Weeks Ending	Area 1†	Area 2†	Area 3†	Total
Nov. 3	.3			.3
10	10.8			10.8
17	40.2			40.2
24	37.6			37.6
Dec. 1	59.9	4		63.9
8	74.9	.1		75
15	130	.1		130.1
22	113		.1	113.1
29	73.4		1	74.4
Jan. 5	91.1	1	.1	92.2
12	83.1	1	.4	84.5
19	165.1		2.3	167.4
26	152.4		3.4	155.8
Feb. 2	208.7	.1	5.3	214.1
9	238.5		1.7	240.2
16	302.7	1	1.5	305.2
23	360.5	1.1	.8	362.4
Mar. 2	336.8		1.3	338.1
9	311.6	.3	.5	312.4
16	402.6	.1	3.3	406
23	372.5	1.4	.8	374.7
30	404.5	.3	.6	405.4
Apr. 6	246.2	.2	16	262.4
13	199.8	.1	100.7	300.6
20	214.4	3	351.5	568.9
27	139	51.6	550.7	741.3
May 4	149.7	127.8	526.5	804
11	143.8	174	347.2	665
18	95.1	224.8	129.7	449.6
25	19.3	177.1	18.2	214.6
June 1	4	123.4	7.9	135.3
8	.3	74.1	2.3	76.7
15		22.6	.3	22.9
22		9.5		9.5
29		.8		.8
Total	5,181.8	999.5	2,074.1	8,255.4

*Weekly shipments of less than .1 carload omitted.
†See Fig. 6 for counties included.

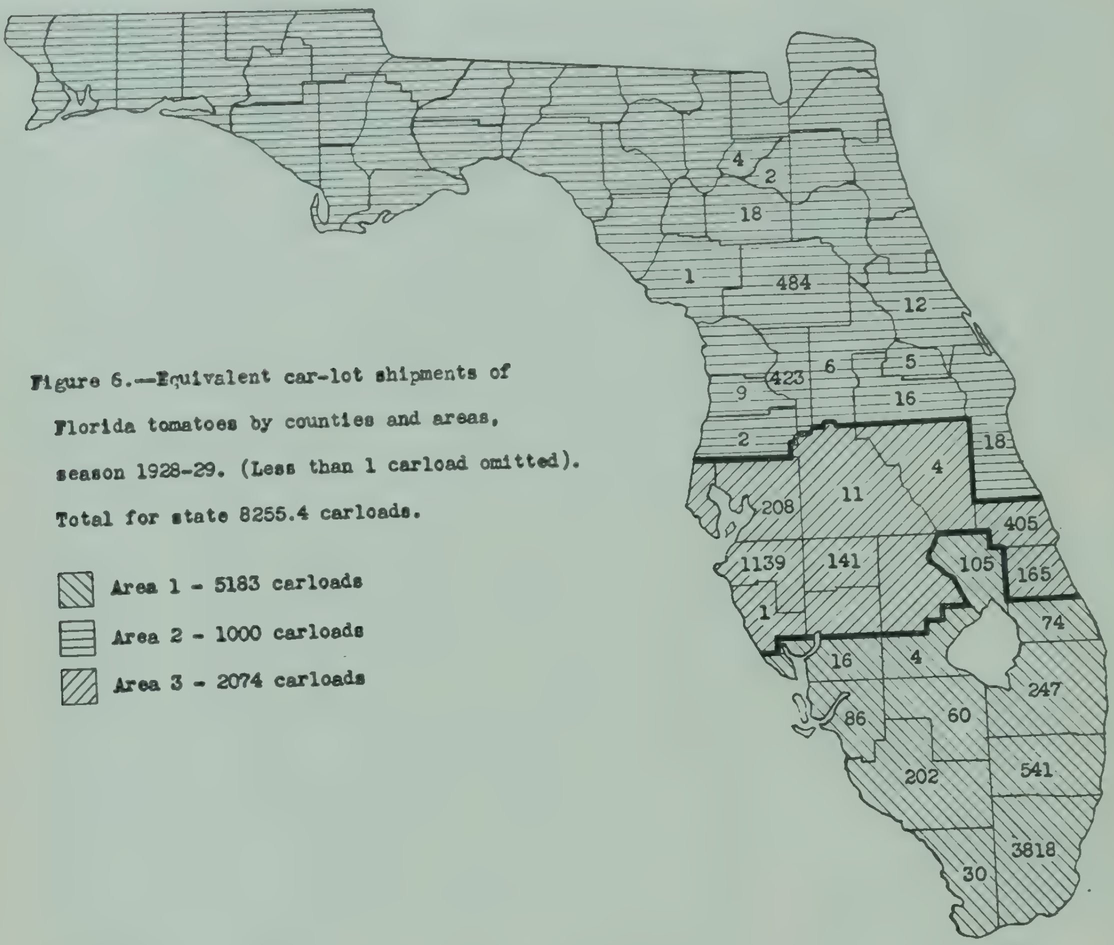

Figure 6.—Equivalent car-lot shipments of Florida tomatoes by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 8255.4 carloads.

market with the bulk of its shipments in a very narrow space of four weeks time (Table VIII) in which it marketed 1,775.9 carloads of its total of 2,074.1 carloads. However, Area 3 had a higher peak than any other area, even more than Area 1 experienced when no other state was competing. Area 1 was forced to compete with imports which were heavy during February and March[5].

GREEN BEANS

Green beans are widely grown in the United States, and probably every county in Florida produces at least a few. The total shipments for the 1928-29 season in Florida were 5,291.7 equivalent carloads (Table IX). Three of the areas indicated (Table X) are heavy shippers. Area 4 (Broward and Dade counties) started off early in November and continued to ship heavily until early April (Table X). Area 3 (all counties bordering on Lake Okeechobee) started the same week but had a high peak

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[5] Noble, C. V., and Marvin A. Brooker. Florida Truck Crop Competition Fla. Agri. Exp. Sta. Bul. 224:1931.

TABLE IX.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA GREEN BEANS (INCLUDING LIMA BEANS) BY COUNTIES, SEASON 1928-29.*

Weeks Ending	Alachua	Gilchrist	Levy	Manatee	Marion	Union	Orange	Seminole	Sumter	Broward	Dade	Glades	Hillsborough	Indian River	Palm Beach	Brevard	Hardee	Martin	Okeechobee	Hendry	Lake
Oct. 20	.1																				
27	.4	.1	.1	.1	.7	.1															
Nov. 3	2.2		.2		2.9	.2	.4	1.3	.4												
10	3		1.6		2.8	.5	1.3	3.8	1.9	1.1	.9	.3	.1	1.3	.2						
17	3.5		1.4	.3	1.3	.2	8.4	9.6	10.5	10.9	2	.8		12.8	.9	.1	.2	.1	.2		
24	2.7		.2	2.7	1.4	.7	8.2	12.7	21.3	22.8	3.2	9.4	3.2	23.8	5.3	.3	2.6	.6	.1	8.5	1.4
Dec. 1	.8			2.4	.7		6	1.1	7.9	25.6	2.8	2.1	2	11.3	6.8	.2	.9	3.4		.2	2.3
8	.1			3.7	.4		7.3	4.2	6.4	48.5	3.4	2.9	2.4	19.8	10.2	.7	1	10.2	.7	1.7	1
15				2.7			1.1	1	.4	50	4.9	.9	.1	14.5	8.6	.3	.1	7.6	.5	.5	.2
22	.1			1.1			.1		.1	49.9	5.1	3.2		18.1	6.9	.5	.2	8.4	2	1	.2
29				.3						27.8	6.8	1		8	4.4	1.3		6.7	.9	1.6	.1
Jan. 5				.1						20.6	4.6	.5		4.8	5.3	.2		5	.3	.4	
12				.1						28.4	4.9	.3		3.6	4	.3		3.4	.1	.1	
19										44.6	8.7	.1	.1	1.3	5.6	.2		5.4	.1		
26										74.6	6.1			5	12.1	.3	.1	9.2	.3	.1	
Feb. 2				.1						56.2	15.1			3.5	21.1	.6		13.8	.6		
9				.1						50.3	4	.4	.2	6.8	30.4	.7		14.9	.6		
16				.2						51.1	17.4	1.1		8.6	52.6	.6	.1	16.5	2.6	.3	
23				.1						72.7	7.6	1.8		10.9	78.5	.4	.1	17.8	1.9	1.3	
Mar. 2				.1				.1		61.1	13.9	4.7		20.9	174.1	.3	.1	12.6	9.9	7.5	
9				.2				.1		55.2	14.9	7.2		20.9	146.9	.3	.5	15.7	9.2	6.5	
16				.6					.3	66.4	10.9	4.4	.4	22.6	120	1.3	3.3	13.1	8.8	13.4	.1
23				.8				.1	.9	40.7	7.4	2.2	3.9	21.3	124.5	.7	7.1	5.9	7	8	.2
30	.1			1	.1		.4	.3	5.2	44.3	8.7	2.1	13.8	16.4	139.7	.8	12.8	5.4	6.2	9	1.6
Apr. 6	.5		.8	1.3	1.9		1.4	2.4	34.4	12.7	13.2	2.5	25.9	7.9	149,9	1	6.4	3.9	4.7	14	2.1
13	23.8		5.8	3	36.5	1.7	.8	6.6	112.3	2	4.9	4.3	37.7	4.4	152.9	.6	6	1.8	4.1	14.9	5.5
20	49.5	.1	9.8	3.6	101.5	5.5	.4	5.3	81.9	.1	4.2	2.6	22.6	1.7	125.3	.4	5.6	.7	1.4	13.5	8.8
27	69.2		10.4	5.7	141.6	14.3	2.4	3.9	54.2		1.6	3.7	7.1	.2	95.6	.3	2.4	.8	.7	2.5	12.7
May 4	55.9		3.5	2.3	135.6	12.3	1.7	7.3	16.2		1.2	.8	9.1	.1	69.9	.1	1.6	1.5	1.3	5.1	5.5
11	35.6		2.3	1.1	85.9	9.5		3.3	1.8		.4	1	1.8	1	40		.8	.1	2.4	2.2	1.6
18	12.7		.2	1.8	15.1	3		.6	.6			.1	.9		25.1		.5		3		.1
25	10.1	.1	.1	1.6	5.3	.2			.2				.3		1.2		.2		.6		.1
June 1	5.2			.5	2.5	.1			.1				.2		.3		.1		.2		.1
8	3.1				1.1														.1		
15	1.2				.5	.1													.1		
22	.7				.3																
29	.2				.1	.1															
July 6	.1				.1	.1						.1							.1		
13	.1																				
Total	280.9	.3	36.4	37.6	538.3	48.6	39.9	63.7	357	917.6	178.8	60.5	131.8	271.5	1,618.3	12.5	52.7	184.5	70.7	112.3	43.6

*Weekly shipments of less than .1 carload omitted.

TABLE IX.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA GREEN BEANS (INCLUDING LIMA BEANS) BY COUNTIES, SEASON 1928-29—Continued.*

Weeks Ending	Lee	St. Lucie	Sarasota	Volusia	Collier	Osceola	Monroe	Highlands	Pasco	Polk	Charlotte	DeSoto	Hernando	Bradford	Citrus	Putnam	Clay	St. Johns	Flagler	Total
Oct. 20																				.1
27																				1.5
Nov. 3																				7.6
10																				18.8
17																				63.2
24	.7	.2	.1																	132.1
Dec. 1	.1	1.4	.5																	78.5
8	2.6	1.6		1.1																129.9
15	.4	1.6	.2		.1															95.7
22	1.1	2.6	.2		.1	.2														101.1
29	.6	1.6																		61.1
Jan. 5		1.2				.1														43.1
12	.1	1				.2														46.5
19	.1	.6			.2	.1														67.1
26	.3	2		1																111.1
Feb. 2	.5	2.7			.1															114.3
9	.6	2.2				.1														111.3
16	.6	2.5			.1	.8														155.1
23	.9	3.1			.3	.4	1													198.8
Mar. 2	.7	2.1		.2	.4															308.7
9	.9	1.9			.3															280.7
16	.8	2.4		5	.1	.4		.1	.2	.2										274.8
23	.5	3.5							.2	1	.1									236
30	.5	4.1	.6			.1		.1	.7	1.3		.1	.1							275.5
Apr. 6	.5	1.2	.2			.2			5.6	3.8			.3							298.7
13		.3	.2			.5			7.7	6.3			1.1	4.8	.1					450.6
20		.2	.2	.1		.4			2.5	4.5			1.9	14	.1	.2				468.6
27			.1	.2		.4		.1	2.3	1.9		.2	7.5	22.4	.1	1.3	.1	.2		466.1
May 4						.3		.1	1	1			1.1	30.8		.4	.2	.2	.1	366.2
11			.1	.1					.4	1.1		.1	.4	20			.1	.1		213.2
18				.1					.3	.8			.1	5.5		.1	.1	.4		71.1
25									.1	.4			.1	.9		.3		.3		22.1
June 1										1				.5		.2		.2		11.2
8										1				.4		.2		.3		6.2
15														.4						2.3
22														.1						1.1
29														.1						.5
July 6														.2			.2			.9
13														.2						.3
Total	12.5	40	2.4	7.8	1.7	4.2	1	.4	21	24.3	.1	.4	12.6	100.3	.3	2.7	.7	1.7	.1	5,291.7

*Weekly shipments of less than .1 carload omitted.

TABLE X.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF FLORIDA GREEN BEANS (INCLUDING LIMA BEANS) BY AREAS, SEASON 1928-29.*

Weeks Ending	Area 1†	Area 2†	Area 3†	Area 4†	Area 5†	Other Counties†	Total
Oct. 20	.1	....	....	....	....	....	.1
27	1.2	.1	....	....	....	.2	1.5
Nov. 3	5.7	....	....	....	....	1.9	7.6
10	8.2	.1	.5	2	1.3	6.7	18.8
17	15.5	.5	2	12.9	12.9	19.4	63.2
24	27.5	8.6	23.9	26	24.3	21.8	132.1
Dec. 1	11.7	5.8	12.5	28.4	12.9	7.2	78.5
8	7.9	7.1	25.7	51.9	22.1	15.2	129.9
15	.6	3.1	18.1	54.9	16.4	2.6	95.7
22	.4	1.5	21.5	55	21.2	1.5	101.1
29	.1	.3	14.6	34.6	10.9	.6	61.1
Jan. 5	....	.1	11.5	25.2	6.2	.1	43.1
12	....	.1	7.9	33.3	4.9	.3	46.5
19	....	.1	11.2	53.3	2.1	.4	67.1
26	....	.1	21.7	80.7	7.3	1.3	111.1
Feb. 2	....	.1	35.5	71.3	6.8	.6	114.3
9	....	.3	46.3	54.3	9.7	.7	111.3
16	....	.3	73.1	68.5	11.7	1.5	155.1
23	....	.2	101.3	80.3	14.4	2.6	198.8
Mar. 2	....	.2	208.8	75	23.3	1.4	308.7
9	....	.7	185.5	70.1	23.1	1.3	280.7
16	.4	4.5	159.7	77.3	26.3	6.6	274.8
23	1.1	12.8	147.6	48.1	25.5	.9	236
30	7	29.5	162.4	53	21.3	2.3	275.5
Apr. 6	38.9	37.6	175	25.9	10.1	11.2	298.7
13	184.6	53.2	178	6.9	5.3	22.6	450.6
20	261.2	36.5	143.5	4.3	2.3	20.8	468.6
27	314.4	17.2	103.3	1.6	.5	29.1	466.1
May 4	256.3	14	78.6	1.2	.2	15.9	366.2
11	154.4	4.9	45.7	.4	.1	6.8	213.2
18	37	4	28.2	....	....	1.9	71.1
25	16.8	2.5	1.8	....	....	1	22.1
June 1	8.5	1.8	.5	....	....	.4	11.2
8	4.6	1	.1	....	....	.5	6.2
15	2.2	....	.1	....	....	....	2.3
22	1.1	....	....	....	....	....	1.1
29	.5	....	....	....	....	....	.5
July 6	.5	....	.2	....	....	.2	.9
13	.3	....	....	....	....	....	.3
Total	1368.7	248.8	2046.3	1096.4	324	207.5	5291.7

*Weekly shipments of less than .1 carload omitted.
†See Fig. 7 for counties included.

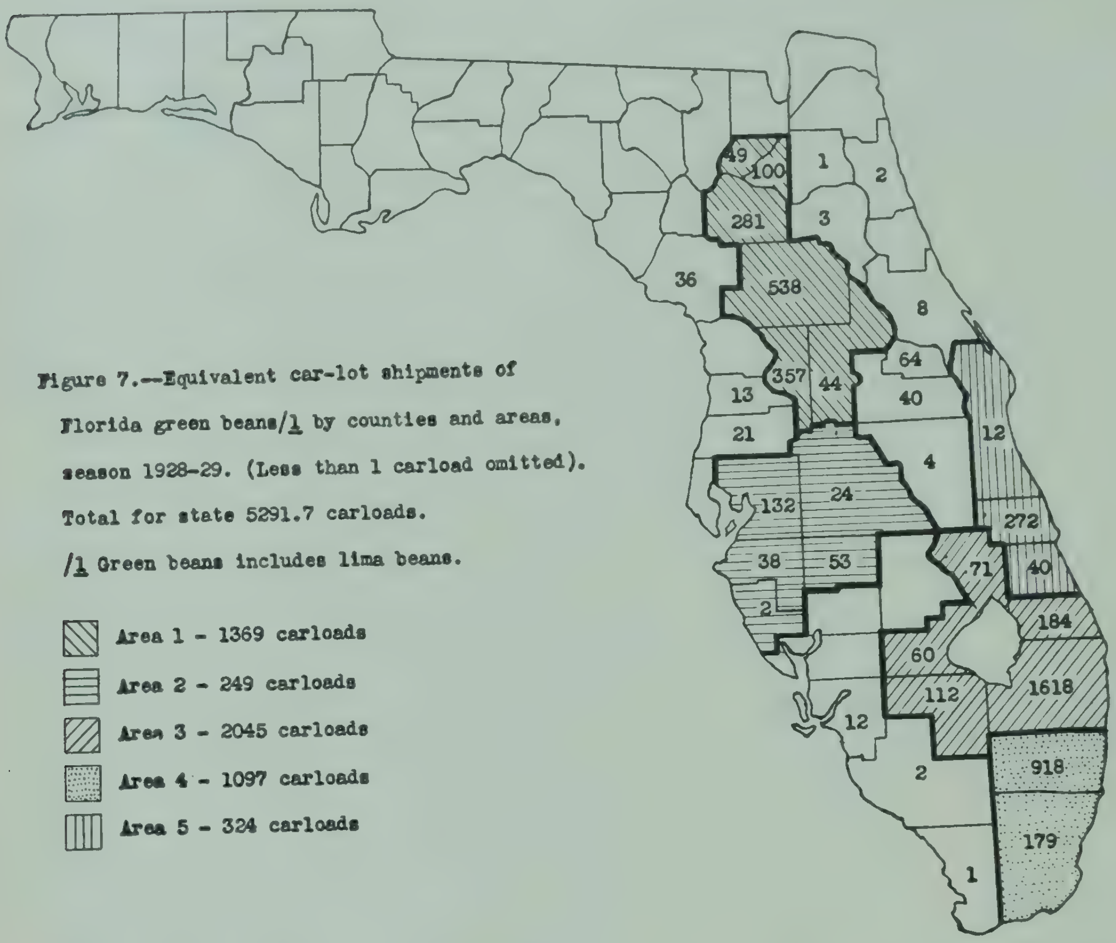

Figure 7.—Equivalent car-lot shipments of Florida green beans/1 by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 5291.7 carloads.

/1 Green beans includes lima beans.

▧ Area 1 - 1369 carloads
▤ Area 2 - 249 carloads
▨ Area 3 - 2045 carloads
░ Area 4 - 1097 carloads
▥ Area 5 - 324 carloads

over a long season of 10 weeks from the middle of February through April. Area 1 (Alachua, Marion and Sumter counties) had a fall crop and a spring crop, both of which covered narrow seasons, and the spring crop had a very high peak which climaxed April 27 after Area 4 had practically finished and Area 3 was on the decline.

EARLY WHITE POTATOES

For the season 1928-29 Florida shipped 5,262.5 equivalent carloads of early white potatoes (Table XI). The production of this crop in Florida is largely concentrated in the territory known as the Hastings Area, designated as Area 1. Included in Area 1 are the smaller sections known by the shipping points as Bunnell and LaCrosse. In order to get an idea of the importance of Area 1, it will be noted in Fig. 8 that this area shipped 4,779 equivalent carloads from its nine counties while the remainder of the volume moved from 27 counties, with no one of these 27 counties shipping more than a total of 70 carloads. Observation of Table XII shows that Area 1 had competition from

TABLE XI.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA EARLY WHITE POTATOES BY COUNTIES, SEASON 1928-29.*

Weeks Ending	St. Johns	Seminole	Hillsborough	Hardee	Bradford	Manatee	Okeechobee	Broward	Dade	Hernando	Palm Beach	St. Lucie	Brevard	Indian River	Lee	Martin	Osceola	Charlotte	Flagler
Oct. 6	.1																		
13	.1																		
20																			
27																			
Nov. 3																			
10																			
17																			
24																			
Dec. 1		.1																	
8			.1																
15			.2	.1															
22				.1	.1	.1													
29							1												
Jan. 5				.1															
12								.1	.1	1									
19								.1	.5		.1								
26							1		1.2		.1								
Feb. 2						.1	1	.1	1.5		.1								
9						.1		.1			.1								
16						.2		.1				2							
23						1.4		.3			.1	8	1	5	3.1	1			
Mar. 2						1.1			2.3		.1	4		8	4		1		
9	2			.1		1		1	6.5		.3	10		2	6			2	10
16	52.7			.3					10		.2	18		12.1	9.1	8	1	3	27
23	145.2		.4	.7				3	9.1		6.2	9	1	15	7.1	6		1	66.1
30	211.1		5.5	6.6		1.1	4		14.4		2.1	1.5	3	5.3	.1	1.1			99.7
Apr. 6	226.2		5.5	1.3		5.1	3		8.2		1	2	.7	1			1		98.9
13	435.4		7.3	2.2		1			5.1		4	.6							23
20	516.4		8.2	2.1	.3	4	1		3	1	5								29
27	728.6		4.2	1	1.2				3	1	3				1				23.3
May 4	618.1		2.1	1	7.1	1			4		4						1		15.8
11	112.8		1		1				1										1
18	8.4								.1		4								.6
25	4.7										6								
June 1	1								.3		1								1
8	.1																		
15	1																		
22	3																		
29	.6																		1
July 6	3																		
13	1																		
20	4.1																		
27	2																		
Aug. 3	1																		
10	.1																		

SEASON 1928-29—Continued.*

Weeks Ending	Glades	Volusia	Duval	Putnam	DeSoto	Polk	Hendry	Highlands	Lake	Marion	Pasco	Sarasota	Clay	Alachua	Union	Levy	Escambia	Orange	Total
Oct. 6																			.1
13																			.1
20																			
27																			
Nov. 3																			
10																			
17																			
24																			
Dec. 1																			.1
8																			.1
15																			.3
22																			.3
29																			1
Jan. 5																			.1
12																			1.2
19																			.7
26																			2.3
Feb. 2																			2.8
9																			.3
16																			2.3
23																			19.9
Mar. 2																			20.5
9	.2	3																	44.1
16		4	2	1															148.4
23		21	1.6	33.7	4	.1													330.2
30	2.1	42		77.7	7		4	2	.1	.1	.2	3							493.7
Apr. 6		38.5		44.2	10	1	8	2	.1		.1		6						463.8
13		18		107.5			1	1			.2		24						630.3
20		15.2		106.7									20	3	5				719.9
27		12		105.9			2			2	.1		30	39	8				965.3
May 4		6		71.8	1		5	1		9			113	101.1	17	3			982
11		1		23.8						2			60	103.1	7				313.7
18		2		3					1	3			1	10	1		24	1	59.1
25						1											21		32.7
June 1																	1		4.3
8																			.1
15																			1
22														1					4
29														3					6.6
July 6																			3
13																			1
20																			4.1
27																			2
Aug. 3																			1
10																			.1
Total	2.3	162.7	3.6	575.3	24	2.1	20	6	1.2	16.1	.6	3	254	260.2	38	3	46	1	5,262.5

*Weekly shipments of less than .1 carload omitted.

TABLE XII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA EARLY WHITE POTATOES BY AREAS, SEASON 1928-29.*

Weeks Ending	Area 1†	Other Counties†	Total
Oct. 6	.1		.1
13	.1		.1
20			
27			
Nov. 3			
10			
17			
24			
Dec. 1		.1	.1
8		.1	.1
15		.3	.3
22	.1	.2	.3
29		1	1
Jan. 5		.1	.1
12		1.2	1.2
19		.7	.7
26		2.3	2.3
Feb. 2		2.8	2.8
9		.3	.3
16		2.3	2.3
23		19.9	19.9
Mar. 2		20.5	20.5
9	15	29.1	44.1
16	86.7	61.7	148.4
23	267.6	62.6	330.2
30	430.5	63.2	493.7
Apr. 6	413.8	50	463.8
13	607.9	22.4	630.3
20	695.6	24.3	719.9
27	948	17.3	965.3
May 4	949.9	32.1	982
11	309.7	4	313.7
18	26	33.1	59.1
25	4.7	28	32.7
June 1	2	2.3	4.3
8	.1		.1
15	1		1
22	4		4
29	4.6	2	6.6
July 6	3		3
13	1		1
20	4.1		4.1
27	2		2
Aug. 3	1		1
10	.1		.1
Total	4,778.6	483.9	5,262.5

*Weekly shipments of less than .1 carload omitted.
†See Fig. 8 for counties included.

other counties throughout the greater part of its shipping season. Some counties in south Florida, such as Dade, Indian River, Lee, Manatee, and St. Lucie, marketed a few carloads during a period of 10 weeks before Area 1 began shipping, light shipments being made as early as the week ending December 1. If the cost of early production is not too great, and a more valuable crop would not be displaced, this would indicate an opening for a greater production of early white potatoes in those few counties farther south where the climate permits. This would be especially true in January and February following years of a short crop stored in the north.

When the season for Area 1 was over, or practically over, Escambia County in the extreme west end of the state sent 46 carloads of potatoes to market.

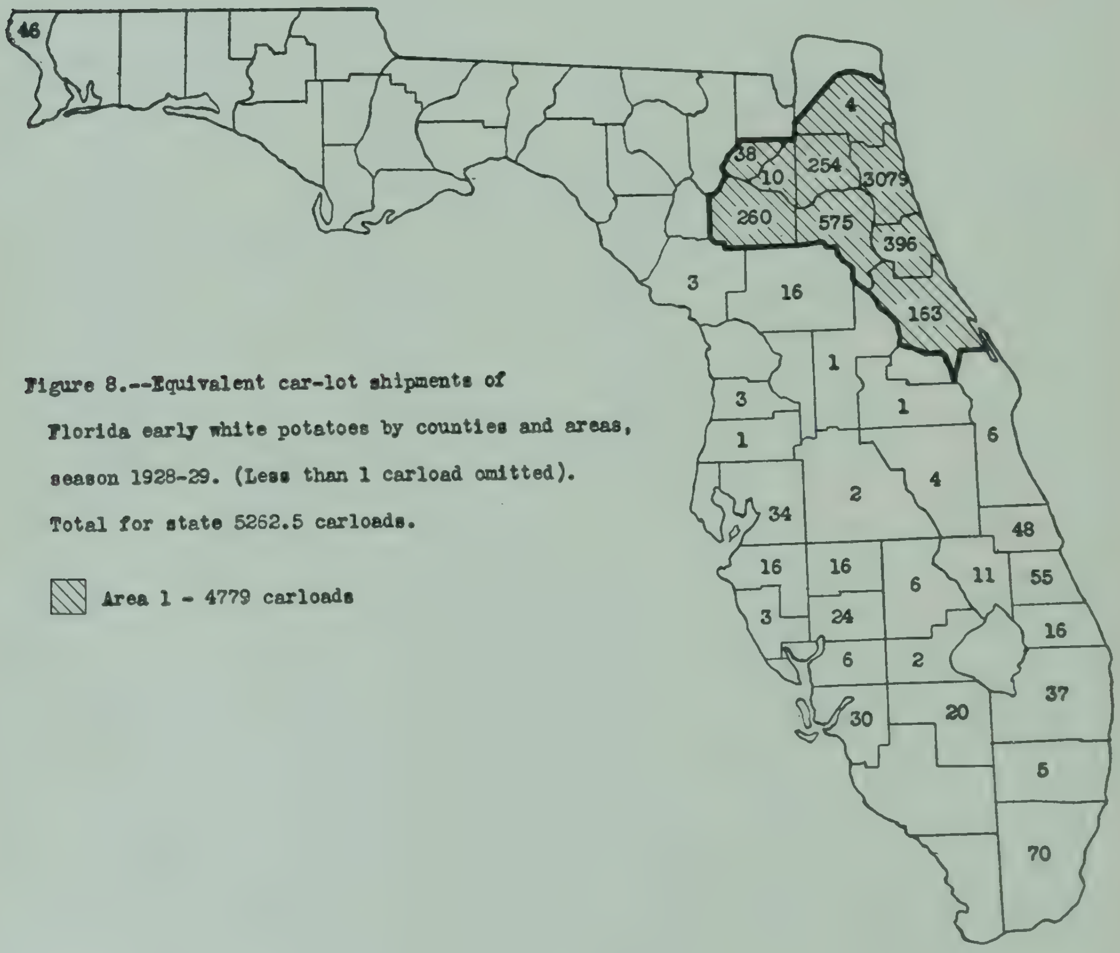

Figure 8.--Equivalent car-lot shipments of Florida early white potatoes by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 5262.5 carloads.

CABBAGE

Cabbage is another important crop, as shown by the fact that 3,173.1 equivalent carloads were shipped during the season of 1928-29. With the exception of Areas 1 and 6 (Fig. 9), the peaks are all within a period of three weeks' time (Table XIV).

There was no fall crop from any place in the state. Area 1 had its peak on January 19, when it shipped a total of 60 carloads of cabbage. Area 2 did not reach its peak until March 23. The three weeks of March 9, 16 and 23 contain the peaks for Areas 2, 3, 4, 5 and other counties.

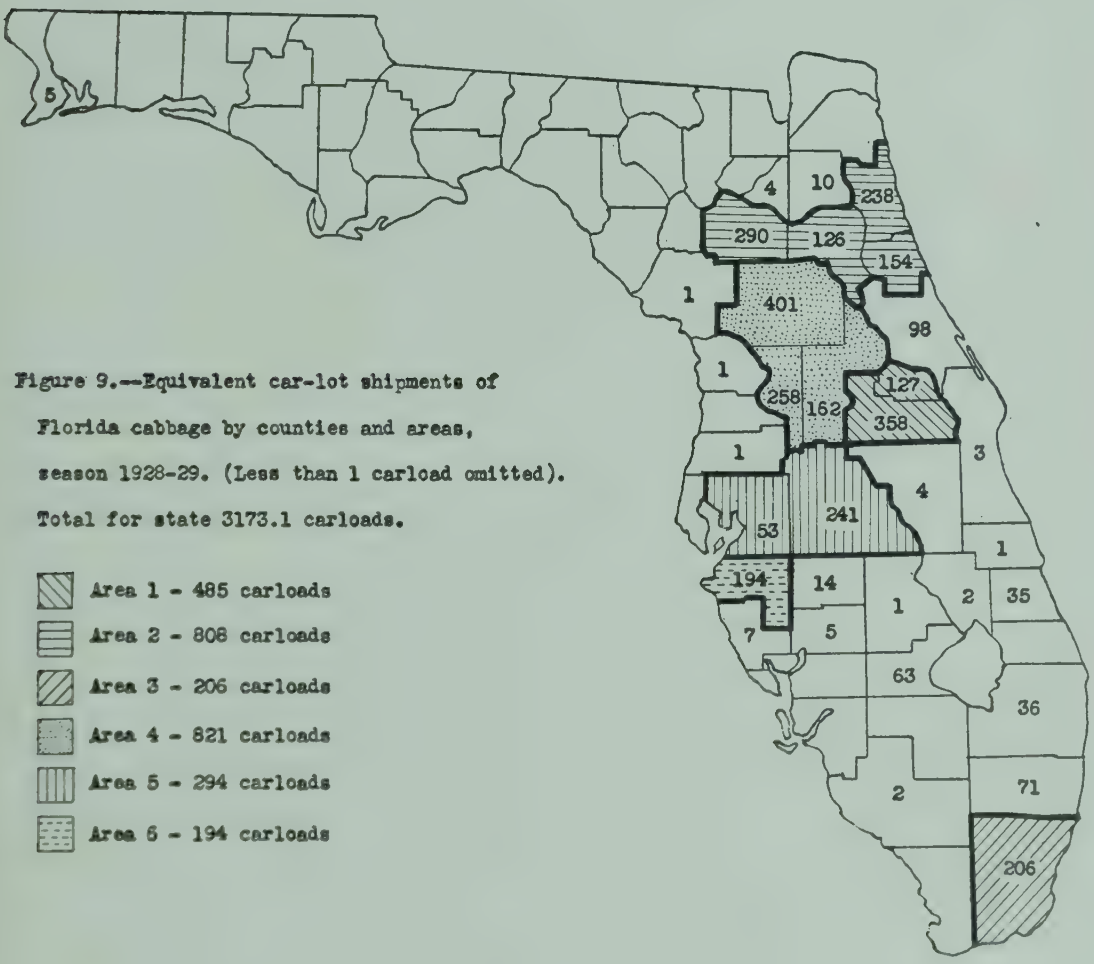
Figure 9.—Equivalent car-lot shipments of Florida cabbage by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 3173.1 carloads.

TABLE XIII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA CABBAGE BY COUNTIES, SEASON 1928-29.*

Weeks Ending	Orange	Seminole	Alachua	Dade	Hillsborough	Manatee	Polk	Sumter	Volusia	Broward	Glades	DeSoto	Lake	Marion	Palm Beach	Putnam	St. Lucie	Clay
Dec. 8	1	.1																
15	3	.1																
22	11		1															
29	17	1		.2														
Jan. 5	26	5	3	.6	2	2	4	1	1.1									
12	33	9	1	4.5	1	10	2	2	2	3	1							
19	40	20	8	5.5	7	22	12	6	4	4	2	1	1	2	1	1	1	
26	42	14	15	6.7	2	21	19	12	11	2	3		2	6		5	2	.2
Feb. 2	35	11	19	21.6	8	34	21	11	7	3	5		9	12		9	2	.2
9	25.1	18.1	17	10.8	6	23.1	21	14	8	6	4.1		9	20	1	12		.1
16	21.2	6.1	32	21.5	4	38	27	23	13	7	6		26	37		12	1	
23	18	18	22	24.3	6	29	25	24	2	10	3		22	30	5	13		
Mar. 2	10	10	32	19.9	5	10.1	23	21	9	8	2	2	26	62		13.1	5	
9	14	4	36.1	24.9	6	5	27	49	8	9	3		19	50	5	21	3	
16	13	4	31.2	22.6	4		29	49	12.1	5	7	2	20	73.1	5	8	5	1
23	17	4	42	9.1	2		18	23	13	8	6		17	68	10	21	7	3
30	15	2	25	20.9			10	18	6.1	6	5		10	37	7	8	6	3
Apr. 6	9	1	3	11.3			3	4	2		7		1	2	1	2	3	1
13	2			.3				1			5			1		1		1
20	3			.4							3							
27	1			.3							1			.1	1			
May 4			1															
11	2		1															
18														1				
25			1															
June 8				.1														
Total	358.3	127.4	290.3	205.5	53	194.2	241	258	98.3	71	63.1	5	162	401.2	36	126.1	35	9.5

*Weekly shipments of less than .1 carload omitted.

TABLE XIII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA CABBAGE BY COUNTIES, SEASON 1928-29—Continued.*

Weeks Ending		Flagler	Osceola	Sarasota	St. Johns	Hardee	Collier	Brevard	Citrus	Okeechobee	Hernando	Highlands	Indian River	Pasco	Bradford	Escambia	Levy	Total
Dec.	8																	1.1
	15																	3.1
	22																	12
	29																	18.2
Jan.	5																	44.7
	12																	68.5
	19																	137.5
	26	2	1	3	3													171.9
Feb.	2	6	2	1	13.1	2												231.9
	9	6			23	1												225.3
	16	12		2	21		1											310.8
	23	8		1	24	1												285.3
Mar.	2	23	1		30	3	1											316.1
	9	16			33	5												338
	16	24			45	1		1	1	1								364
	23	28			25	1		2			.1	1						325.2
	30	24			20								1					224
Apr.	6	4			1									1				56.3
	13	1								1					1			14.3
	20																	6.4
	27																	6.4
May	4														1	2		5
	11														1	3		4
	18														1			2
	25																1	1
June	8																	.1
Total		154	4	7	238.1	14	2	3	1	2	.1	1	1	1	4	5	1	3,173.1

*Weekly shipments of less than .1 carload omitted.

TABLE XIV.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA CABBAGE BY AREAS, SEASON 1928-29.*

Weeks Ending	Area 1†	Area 2†	Area 3†	Area 4†	Area 5†	Area 6†	Other Counties†	Total
Dec. 8	1.1	....	....	....	....	....	....	1.1
15	3.1	....	....	....	....	....	....	3.1
22	11	1	....	....	....	....	....	12
29	18	....	.2	....	....	....	....	18.2
Jan. 5	31	3	.6	1	6	2	1.1	44.7
12	42	1	4.5	2	3	10	6	68.5
19	60	9	5.5	9	19	22	13	137.5
26	56	25	6.7	20	21	21	22.2	171.9
Feb. 2	46	47.1	21.6	32	29	34	22.2	231.9
9	43.2	58	10.8	43	27	23.1	20.2	225.3
16	27.3	77	21.5	86	31	38	30	310.8
23	36	67	24.3	76	31	29	22	285.3
Mar. 2	20	98.1	19.9	109	28	10.1	31	316.1
9	18	106.1	24.9	118	33	5	33	338
16	17	108.2	22.6	142.1	33	....	41.1	364
23	21	116	9.1	108	20	....	51.1	325.2
30	17	77	20.9	65	10	....	34.1	224
Apr. 6	10	10	11.3	7	3	....	15	56.3
13	2	2	.3	2	....	....	8	14.3
20	3	....	.4	....	....	....	3	6.4
27	1	....	.3	.1	....	....	5	6.4
May 4	....	1	....	....	....	....	4	5
11	2	1	....	....	....	....	1	4
18	....	....	....	1	....	....	1	2
25	....	1	....	....	....	....	....	1
June 8	....	....	.1	....	....	....	....	.1
Total	485.7	808.5	205.5	821.2	294	194.2	364	3,173.1

*Weekly shipments of less than .1 carload omitted.
†See Fig. 9 for counties included.

CUCUMBERS

Florida shipped 2,307.5 equivalent carloads of cucumbers during the 1928-1929 season (Table XV). In this commodity, also, the competition of areas among themselves is serious. There are five of these areas, as shown on the map in Fig. 10. In some seasons Area 1 around Wauchula is on the spring market for a time unmolested by other areas. It was not so fortunate, however, in 1928-29 because its most serious competitors, which are Area 2 (Sumter County) and Area 5 (Orange and Lake counties), came along with it (Table XVI). By the use of board troughs and by banking, Area 2 frequently can come in with or near to Area 1. In fact, in 1929 Area 2 actually had its peak

TABLE XV.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA CUCUMBERS BY COUNTIES, SEASON 1928-29.*

Weeks Ending	Hardee	Alachua	Levy	Marion	Sumter	Union	Gilchrist	DeSoto	Polk	Collier	Hernando	Lee	Dade	Manatee	St. Lucie	Hendry	Lake	Glades	Indian River	Palm Beach	Volusia
Oct. 13	.1																				
20	.3	.4	.3	.2	.1	1															
27	3	.3	.4	.2		2.2	.2														
Nov. 3	12.4	.2	.4	.3	.2	1.2	.1	.1	.1												
10	18.1		.8	1.4	.2	1.9			.1	.2	.1	.2									
17	15.1		.2		.5	.2			.4	.5	.1	1.2	.1	.1							
24	14.4				.5	.1		.1	.2	2.1	.1	5.5	.1	.2	.1						
Dec. 1	1.1											6.3				1	.1				
8	.8									.1		3.5	.1	.1		4		.1	.1	.1	1
15												1.3				2		.1	2.4		
22												1.1	.1					.1	1.5	.1	
29												.1	.1					.1	.2	.1	
Jan. 5																				.1	
12																				.2	
19																				.1	
26																				.1	
Feb. 2													.3							.1	
9																				.2	
16													.2							.1	
23													.1							.1	
Mar. 2												.1	.6							.2	
9	.2				.3								.4					.1		.1	
16	4.8				11.7					.3			.3				.2	.1	.1	.1	
23	24.8				79.2				.1	.1		.2	.4	.3		1	1.3		.1	.1	
30	109.3			.3	155.9			.1	.5		.1	.3	.2	3.3			2.2		.5	.1	
Apr. 6	100.9			.9	104.4			.4	1		.3		.2	9.8			3.1		.7		
13	80.4		9	1.2	67.9			.5	.5		.2		.1	14.7			16.2		.2		
20	26.5	3.4	77.3	9.1	19			.2	.5		.1		.2	12.4			14.3		.1		
27	11.6	82	190.2	38.2	4.6	2.1	.1		.3		1.3			2.2			5.2		.1		
May 4	1.4	126.1	122.8	31.2	.4	3.2	.1		.1		1.2			.1							2
11		126.1	29	6.3		4.4															.1
18		60.3	.4	2.4		3.3	.1														
25		1.4				.1	.1														
June 1			.3																		
8		.2																			
Total	425.2	400.4	431.1	91.7	444.9	19.7	.7	1.4	3.8	3.3	3.5	19.8	3.5	43.2	.1	8	42.6	.6	6	1.9	3.1

*Weekly shipments of less than .1 carload omitted.

TABLE XV.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA CUCUMBERS BY COUNTIES, SEASON 1928-29—Continued.*

Weeks Ending		Broward	Pasco	Charlotte	Hillsborough	Orange	Martin	Brevard	Osceola	Seminole	Putnam	Sarasota	St. Johns	Okeechobee	Pinellas	Bradford	Citrus	Columbia	Duval	Hamilton	Total
Oct.	13																				.1
	20																				2.3
	27																				6.3
Nov.	3																				15
	10																				23
	17																				18.4
	24																				23.4
Dec.	1																				8.5
	8																				9.9
	15																				5.8
	22																				2.9
	29																				.6
Jan.	5	.1																			.2
	12	.2																			.4
	19	.1																			.2
	26	.4																			.5
Feb.	2	1																			1.4
	9	1.7																			1.9
	16	4																			4.3
	23	1.5																			1.7
Mar.	2	1.6																			2.5
	9	.2	.1																		1.4
	16		.7	.1	.3	.3															19
	23	.1	.8	.1	2.4	3.7	.1														114.8
	30	.3	1.1	.2	3	18.1	.3	.2	1.1	1											298.1
Apr.	6	.1	.5	.1	9.2	27.2	.3	.5	2.1		.1	.4									262.2
	13		.3	.1	16.6	51.2	.2	.2	1.1		.1		.1								260.8
	20		.2		19.4	34	.1	.1	.2		.1		.1	.1	.1						217.5
	27		.4		15	29	.1	.1			1.1		2.1	.2	.2	.5	.1	1			387.7
May	4		.2		1.2	16					1		5.3	.2	.1	.3	.1	4			317
	11				.2	9					4		6	.1		1.2		8			194.4
	18					3					5		5			1		12	.5		93
	25												5			.2		2		3	11.8
June	1																				.3
	8																				.2
Total		11.3	4.3	.6	67.3	191.5	1.1	1.1	4.5	1	11.4	.4	23.6	.6	.4	3.2	.2	27	.5	3	2,307.5

*Weekly shipments of less than .1 carload omitted.

ahead of Area 1 and the peak was also higher. The peak for Area 5 came only one week later than that for Area 1, and the Area 3 (Levy and Marion counties) peak came two weeks after that of Area 5. The peak of Area 4 (Alachua County) shipments was only one week later than that of Area 3. Although each area sold its crop within a narrow period of four or five weeks, it experienced competition from at least three or four other areas. It is true that Area 1 had a light fall crop. One week (November 10) 18 carloads were shipped (Table XVI), and as many as five carloads came from other sections of the state, both north and south, in less than carload amounts but the total fall crop was light.

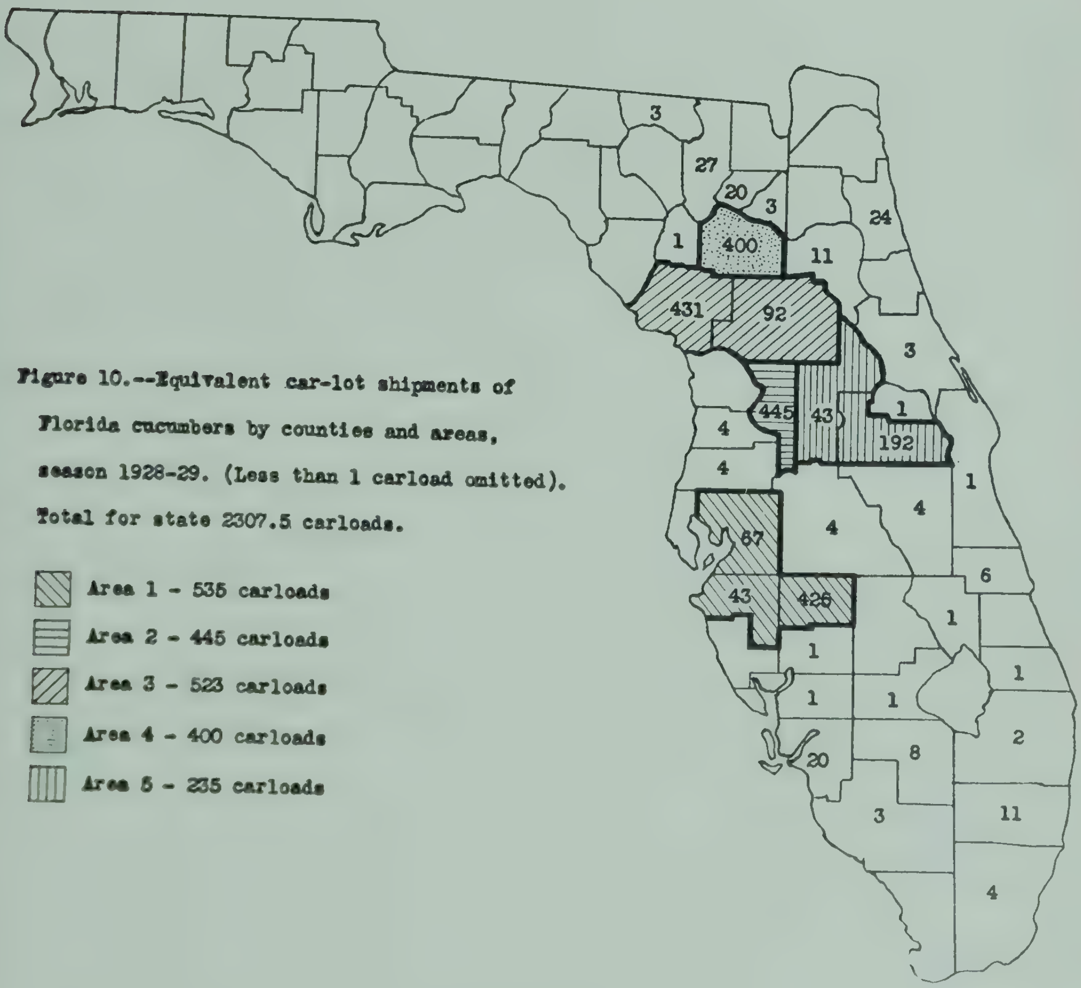

Figure 10.--Equivalent car-lot shipments of Florida cucumbers by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 2307.5 carloads.

TABLE XVI.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA CUCUMBERS BY AREAS, SEASON 1928-29.*

Weeks Ending		Area 1†	Area 2†	Area 3†	Area 4†	Area 5†	Other Counties†	Total
Oct.	13	.1						.1
	20	.3	.1	.5	.4		1	2.3
	27	3		.6	.3		2.4	6.3
Nov.	3	12.4	.2	.7	.2		1.5	15
	10	18.1	.2	2.2			2.5	23
	17	15.2	.5	.2			2.5	18.4
	24	14.6	.5				8.3	23.4
Dec.	1	1.1				.1	7.3	8.5
	8	.9					9	9.9
	15						5.8	5.8
	22						2.9	2.9
	29						.6	.6
Jan.	5						.2	.2
	12						.4	.4
	19						.2	.2
	26						.5	.5
Feb.	2						1.4	1.4
	9						1.9	1.9
	16						4.3	4.3
	23						1.7	1.7
Mar.	2						2.5	2.5
	9	.2	.3				.9	1.4
	16	5.1	11.7			.5	1.7	19
	23	27.5	79.2			5	3.1	114.8
	30	115.6	155.9	.3		20.3	6	298.1
Apr.	6	119.9	104.4	.9		30.3	6.7	262.2
	13	111.7	67.9	10.2		67.4	3.6	260.8
	20	58.3	19	86.4	3.4	48.3	2.1	217.5
	27	28.8	4.6	228.4	82	34.2	9.7	387.7
May	4	2.7	.4	154	126.1	16	17.8	317
	11	.2		35.3	126.1	9	24.3	194.4
	18			2.8	60.3	3	26.4	93
	25				1.4		10.4	11.8
June	1			.3				.3
	8				.2			.2
Total		535.7	444.9	522.8	400.4	234.1	169.6	2,307.5

*Weekly shipments of less than .1 carload omitted.

†See figure 10 for counties included.

PEPPERS

Within the state six areas have been designated (Fig. 11). Besides, there were 17 other counties where peppers were grown and shipped during the year (Table XVII). The total from the state was 2,299.3 equivalent carloads (Table XVIII).

Areas 2 (Broward and Dade counties) and 1 (Hillsborough, Manatee and Hardee counties) led all others as to quantity put on the market. That part of the state usually known as South Florida, and containing Areas 1, 2 and 3, appears to be the only place in the United States where peppers can be grown and marketed profitably throughout the winter. In case there should occur a curtailment of importation of peppers into the United States, South Florida could increase its production, provided the production costs are not too high and provided that other more valuable crops are not displaced.

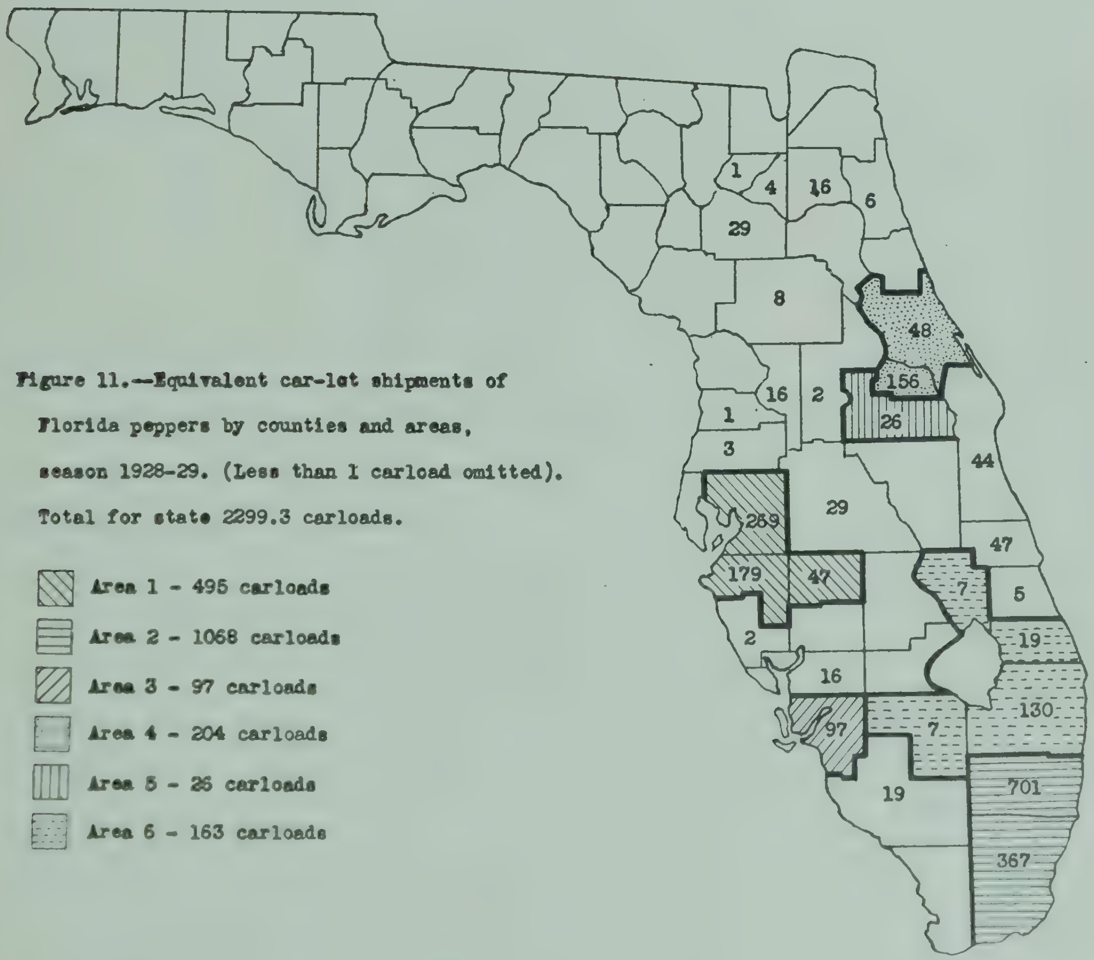

Figure 11.--Equivalent car-lot shipments of Florida peppers by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 2299.3 carloads.

TABLE XVII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA PEPPERS BY COUNTIES, SEASON 1928-29.*

Weeks Ending	Hardee	Brevard	Dade	Hillsborough	Lee	St. Johns	Manatee	Orange	Seminole	Indian River	Glades	Broward	Collier	Charlotte	Martin	Palm Beach	DeSoto	St. Lucie
Oct. 27	.2																	
Nov. 3	.4																	
10	.8																	
17	1.9	.1	.1	1	.1	.1												
24	1	.1	.1		1.4	.2	2.3	2.5	.1									
Dec. 1			.1	1	.3	.1	2.1	1		.1								
8	1.8	.4	.1		2.1		4	.3		.1	.1							
15	1.7	.2	.1	1	2.1		6.1	1.1		.3		.1						
22	4.7	.6	.2		3.9		4.8			.2		.2	.2					
29	2.1	.4	.4		6.1		3.4			.3		.5		.1	.1	.1		
Jan. 5	1.6	.5	.3	2.1	6.3		1.9	1		.4	.1	2.1	.1	.1		.2		
12	1	.9	.5		4.8		2.5			.4		3.9	.1			.1		
19	.9	.9	3.9		2.1		2.5			.4		4.3		.1		.4	.1	
26	1.3	1.4	3.9	4	10.6		3.8			.1		16.9		.2	.1	2.1		.1
Feb. 2	1.1	1.8	10.2		6.5		2.7			.6		20	1		.1	2.3	.1	.1
9	.8	1.2	5.8		13.8		3			1.3		15.1	.2	1	.1	1.4		.1
16	.8	2	19.9		1.3		3.5			.5		14.2		.2	.2	3.6		
23	.8	1.1	20.4		3.5		1.4			1.4		50.9		.5	1.4	8.3		.1
Mar. 2	1.2	1.4	38.1		5.8		.5	.1		2.3		54.2		2.2	.5	3.8		
9	3.3	2.2	15.3	2	8.2		.4			1.6		57.1	.1	1.7	1.7	5.5		.1
16	3.2	3	37.3		2.4		2.4	1		5.5		64	.2	3.4	.4	5.4		
23	5	2.8	16.8	2.1	2.4		4.9	8.1		3		55.6	.1	.8	2.2	13.9		.1
30	1.2	2.5	39.2	2.1	2.1		3.7	2		2		59.1	1.1	1.2	.7	7.1		.1
Apr. 6	1.8	1.5	40.6	.2	3		.7	2		2.6		46.4	1	.1	1.8	6.8		.1
13	.8	3.4	25.1	2.5	3.1		.7			3.2		42.3	2		1.1	3.7		
20	1.1	2.3	37.1	3.7	.1		5.4	1		1.7		33	3		1.5	3.4		.2
27	.9	2.5	25.3	19.2			24.4		.1	3.7		27.4	2	1	1.1	6.6		.3
May 4	1.1	1.6	1.8	29.5			26.3	2.1	5.1	2		55.3	1		1.7	7.4	.1	.2
11	2.2	1.8	1.2	24	1		11.7		6.7	2.1		38.5	1	1	1	8.4		.2
18	1	1.7	1.9	24.5	1.1	.3	19.2	.1	12.5	2.2		33	1	.2	.3	7.7		3.1
25	.5	2.1	17.6	57.2	1	.3	29.3		40.2	3.4		2.3	1	2	1.5	8.4		.1
June 1	.2	.6	.5	42.3	2	.2	3.4		22	2.1		.1	2		.3	10.6		
8	.2	1	.2	27.5		1.1	1	1	24.5	.5			1			3.8		
15	.1	1	.5	22	.1	3	1.1		29	2.4		3.1	1			4.1		
22	.1	1	1.7	1				2	7	.2		1.1			1.1	3.5		
29			.3			.6		1	8.4	.1						1		
July 6			.3															
13			.3															
20																		
27																		
Aug. 17																		
Total	46.8	44	367.1	268.9	97.2	5.9	179.1	26.3	155.6	46.7	.2	700.7	19.1	15.8	18.9	129.6	.3	4.9

*Weekly shipments of less than .1 carload omitted.

TABLE XVII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA PEPPERS BY COUNTIES, SEASON 1928-29—Continued.*

Weeks Ending		Polk	Sarasota	Hendry	Okeechobee	Pasco	Sumter	Volusia	Alachua	Clay	Hernando	Highlands	Marion	Bradford	Lake	Levy	Putnam	Union	Total
Oct.	27																		.2
Nov.	3																		.4
	10																		.8
	17																		3.3
	24																		7.7
Dec.	1																		4.7
	8																		8.9
	15																		12.7
	22																		14.8
	29																		13.5
Jan.	5																		16.7
	12																		14.2
	19																		15.6
	26																		44.5
Feb.	2																		46.5
	9	.1	.1																44
	16																		46.2
	23																		89.8
Mar.	2																		110.1
	9			.1															99.3
	16	.1																	128.3
	23		.1	.1	.1														118.1
	30			.2	.1														124.4
Apr.	6			.1															108.7
	13		.1	.2															88.2
	20	.1	.2	.1															93.9
	27	.1	.1	.1	.1														114.9
May	4	2.3	.3	3	1	.1	.2	.1											142.2
	11	1.6		.3	3.1	.2	.3	1.1	.4	.1	.1								108
	18	4.4		.4		.3	1	6.2	2.9	.6	.1	.1	.2						126
	25	2 9	1	1	1.1	.3	1.6	15.1	2.5	.8	.1		1	.2	.2				194.7
June	1	5.4	.2	1.2	1	.3	2.9	13	4.3	2.1	.1	.1	.1	.3	.1	.1			117.5
	8	9.2		.1		.7	1.6	4	5.4	4.1	.1		3.1	.7	1.1		.1	.2	92.2
	15	2.2			.1	.6	1.8	5	2.3	1.1	.1		2.2	.5	.1				83.4
	22	.6				.3	2.1		8.2	3.1	.1		1.3	.6				.2	35.2
	29	.3				.3	3.1	2	1.4	3.1			.3	.8			.1	.5	23.3
July	6						1	1	.2	1.1			.1	.1					3.8
	13					.1							.1	.1				.3	.9
	20								1.1					.1					1.2
	27								.2					.1				.1	.4
Aug.	17								.1										.1
Total		29.3	2.1	6.9	6.6	3.2	15.6	47.5	29	16.1	.7	.2	8.4	3.5	1.5	.1	.2	1.3	2,299.3

*Weekly shipments of less than .1 carload omitted.

TABLE XVIII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA PEPPERS BY AREAS, SEASON 1928-29*.

Weeks Ending	Area 1†	Area 2†	Area 3†	Area 4†	Area 5†	Area 6†	Other Counties†	Total
Oct. 27	.2							.2
Nov. 3	.4							.4
10	.8							.8
17	2.9	.1	.1				.2	3.3
24	3.3	.1	1.4	.1	2.5		.3	7.7
Dec. 1	3.1	.1	.3		1		.2	4.7
8	5.8	.1	2.1		.3	.1	.5	8.9
15	8.8	.2	2.1		1.1		.5	12.7
22	9.5	.4	3.9				1	14.8
29	5.5	.9	6.1			.2	.8	13.5
Jan. 5	5.6	2.4	6.3		1	.3	1.1	16.7
12	3.5	4.4	4.8			.1	1.4	14.2
19	3.4	8.2	2.1			.4	1.5	15.6
26	9.1	20.8	10.6			2.2	1.8	44.5
Feb. 2	3.8	30.2	6.5			2.4	3.6	46.5
9	3.8	20.9	13.8			1.5	4	44
16	4.3	34.1	1.3			3.8	2.7	46.2
23	2.2	71.3	3.5			9.7	3.1	89.8
Mar. 2	1.7	92.3	5.8		.1	4.3	5.9	110.1
9	5.7	72.4	8.2			7.3	5.7	99.3
16	5.6	101.3	2.4		1	5.8	12.2	128.3
23	12	72.4	2.4		8.1	16.3	6.9	118.1
30	7	98.3	2.1		2	8.1	6.9	124.4
Apr. 6	2.7	87	3		2	8.7	5.3	108.7
13	4	67.4	3.1			5	8.7	88.2
20	10.2	70.1	.1		1	5	7.5	93.9
27	44.5	52.7		.1		7.9	9.7	114.9
May 4	56.9	57.1		5.2	2.1	13.1	7.8	142.2
11	37.9	39.7	1	7.8		12.8	8.8	108
18	44.7	34.9	1.1	18.7	.1	8.4	18.1	126
25	87	19.9	1	55.3		12	19.5	194.7
June 1	45.9	.6	2	35		13.1	20.9	117.5
8	28.7	.2		28.5	1	3.9	29.9	92.2
15	23.2	3.6	.1	34		4.2	18.3	83.4
22	1.1	2.8		7	2	4.6	17.7	35.2
29		.3		10.4	1	1	10.6	23.3
July 6		.3		1			2.5	3.8
13		.3					.6	.9
20							1.2	1.2
27							.4	.4
Aug. 17							.1	.1
Total	494.8	1,067.8	97.2	203.1	26.3	162.2	247.9	2,299.3

*Weekly shipments of less than .1 carload omitted.
†See Fig. 11 for counties included.

STRAWBERRIES

An equivalent of 2,144.8 carloads of strawberries moved from the state, mostly within a period of nine weeks (Table XIX). There are three areas (Fig. 12), two of which are large in volume of shipments. Area 1, known as the Plant City Area, was first to come on the market, starting December 8. Two weeks later this area was shipping more than five carloads per week. It reached its peak March 2 with 324.3 carloads. Area 3, around Starke and Lawtey, reached five carloads February 23 and its peak of 97.4 carloads occurred March 16, only two weeks later than the peak for Area 1. The Winter Garden section (Area 2) did not have any time in which to ship unmolested by the other areas. Its peak of 14.7 carloads moved March 2, the same date as the peak for Area 1 and its season ended before either of the other areas finished shipping.

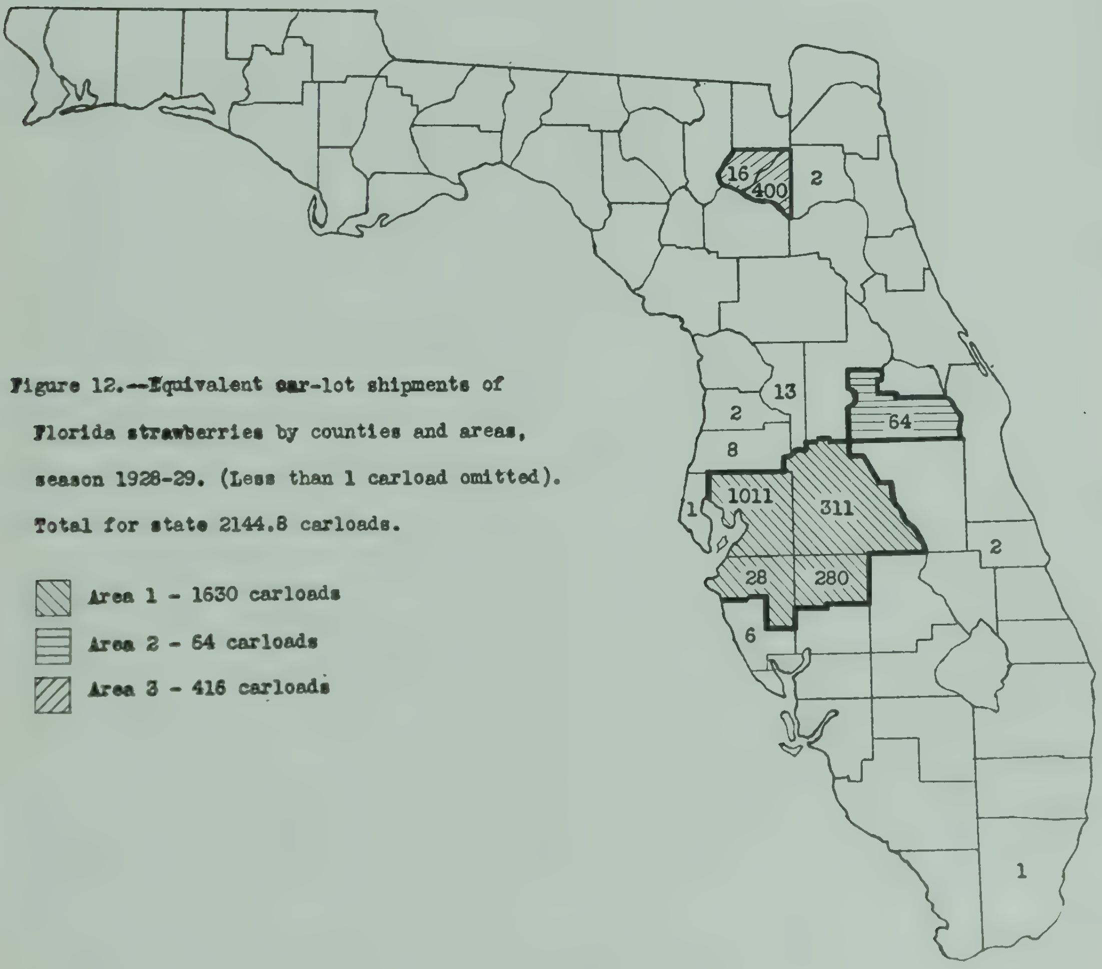

Figure 12.—Equivalent car-lot shipments of Florida strawberries by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 2144.8 carloads.

TABLE XIX.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA STRAWBERRIES BY COUNTIES, SEASON 1928-29.*

Weeks Ending	Hillsborough	Polk	Hardee	Manatee	Orange	Sumter	Sarasota	Dade	Pasco	Pinellas	Bradford	Indian River	Hernando	Seminole	Clay	DeSoto	Union	Alachua	Total
Dec. 8	.5	.4																	.9
15	.7	.4	.3																1.4
22	3	1.6	1.1	.1	.1														5.9
29	4.6	1.9	1.7			.1													8.3
Jan. 5	3.9	3.8	2.8	.1	.3		.1												11
12	7.8	4.2	4.9	.1	.5	.2	.2												17.9
19	17.1	8	8.1	.3	1	.3	.6	.3	.4	.1									36.2
26	70.6	29.2	16.1	2.9	6.2	.3	.7	.1	.1	.2	.3	.3							127
Feb. 2	70.4	26.8	13.5	3	5.3	.4	1.4	.2	.3	.1	1.1	.2	.1	.3					123.1
9	84.1	27.5	23.9	2.2	4.5	1			.7	.1	.8	.2	.1						145.1
16	90.2	27.7	25.6	3.5	5.6	.8			.7		1.6	.2	.1						156
23	152.2	46.4	46	4.9	7.9	1.7	.1	.1	1.5	.1	5	.3	.5		.2	.1	.2		267.2
Mar. 2	204.6	61.1	51.6	7	14.7	2.5	2.1		1.8	.1	27.9	.3	.1	.1	.5		.8	.1	375.3
9	122.1	32.1	32.3	1.9	8.2	2.2	.1		1		49	.1	.7		.2		1		250.9
16	103.3	23.7	29	1.1	5.3	1.3	.1		.9		95.4	.1	.3	.1	.1		2	.1	262.8
23	55.4	10.5	17.4	.8	1	.9	.1		.5		60.2		.2		.1		2.3	.1	149.5
30	17.6	4.2	5.2	.2	3.1	.5	.1		.2		55.8		.1		.4		3.2		90.6
Apr. 6	1.8	1.7	.1			.1			.1		40.6				.3		2.1		46.8
13	.4	.2	.1			.1			.1		19.6				.1		.7		21.3
20	.2					.1			.1		11.3				.1		.8		12.6
27			.2			.1			.1		16.7				.2		1.6	.1	19
May 4			.2								7.8				.1		.8		8.9
11	.1										4.3						.3		4.7
18											2.1						.1		2.2
25											.2								.2
Total	1,010.6	311.4	280.1	28.1	63.7	12.6	5.6	.7	8.5	.7	399.7	1.7	2.2	.5	2.3	.1	15.9	.4	2,144.8

*Weekly shipments of less than .1 carload omitted.

TABLE XX.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA STRAWBERRIES BY AREAS, SEASON 1928-29.*

Weeks Ending	Area 1†	Area 2†	Area 3†	Other Counties†	Total
Dec. 8	.9				.9
15	1.4				1.4
22	5.8	.1			5.9
29	8.2			.1	8.3
Jan. 5	10.6	.3		.1	11
12	17	.5		.4	17.9
19	33.5	1		1.7	36.2
26	118.8	6.2	.3	1.7	127
Feb. 2	113.7	5.3	1.1	3	123.1
9	137.7	4.5	.8	2.1	145.1
16	147	5.6	1.6	1.8	156
23	249.5	7.9	5.2	4.6	267.2
Mar. 2	324.3	14.7	28.7	7.6	375.3
9	188.4	8.2	50	4.3	250.9
16	157.1	5.3	97.4	3	262.8
23	84.1	1	62.5	1.9	149.5
30	27.2	3.1	59	1.3	90.6
Apr. 6	3.6		42.7	.5	46.8
13	.7		20.3	.3	21.3
20	.2		12.1	.3	12.6
27	.2		18.3	.5	19
May 4	.2		8.6	.1	8.9
11	.1		4.6		4.7
18			2.2		2.2
25			.2		.2
Total	1,630.2	63.7	415.6	35.3	2,144.8

*Weekly shipments of less than .1 carload omitted.
†See Fig. 12 for counties included.

SUB-MAJOR CROPS

TABLE XXI.—TOTAL EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA SUB-MAJOR TRUCK CROPS, SEASON 1928-29.

Crop	Equivalent Carloads	Crop	Equivalent Carloads
Lettuce	935.9	Green Corn	292.5
Escarole	676.4	Squashes	236.5
Eggplants	329.1	Okra	227.2
Romaine	292.6	Green Peas	119

LETTUCE

For the season 1928-29 lettuce was the largest of the sub-major crops. In some counties, such as Seminole, it is used as a minor crop preceding celery. There were 935.9 equivalent carloads for the season studied.

It is interesting to notice that geographic location and climatic conditions apparently did not tend to regulate the time of marketing lettuce. Area 1, Seminole County, was on the market first (Table XXIII). It had its peak soon after Area 3 (Winter Garden section) began shipping, and Area 1 had practically finished by the time Area 3 had its peak, yet these areas are only a few miles apart. Even more noticeable, however, Area 3 is about 100 miles northeast of Area 4 (Manatee County), yet they came on the market only two weeks apart and their peaks came the same week. It is evident that climate was not a factor, but that the growers in Seminole County fit their time of planting to their crop rotation and they grow lettuce early, before celery rather than let the ground lie idle. On the other hand, Area 2 (Alachua and Marion counties) marketed the bulk of its crop during the month of March as would be expected, since it is a northern area. There was but little direct competition of Area 2 with other areas in the state.

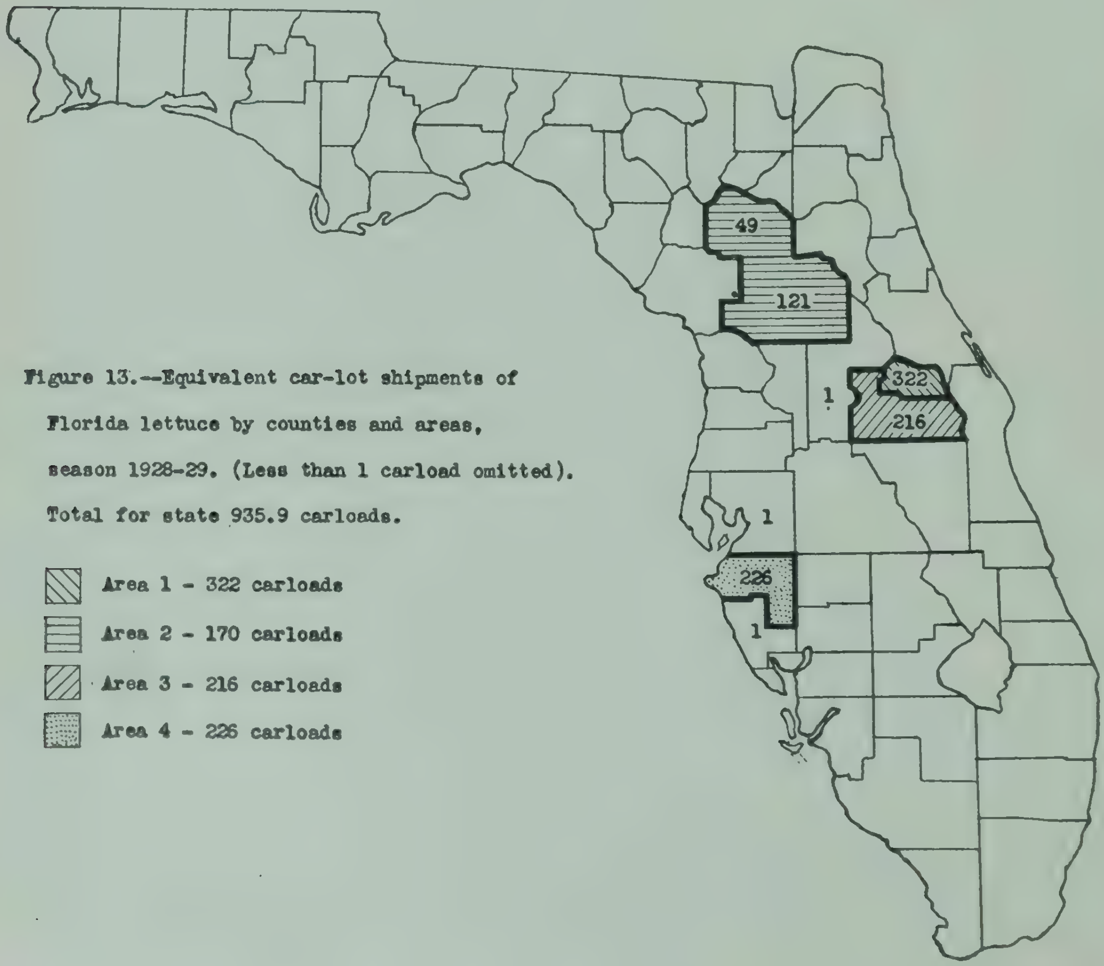

Figure 13.--Equivalent car-lot shipments of Florida lettuce by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 935.9 carloads.

TABLE XXII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA LETTUCE BY COUNTIES, SEASON 1928-29.*

Weeks Ending	Seminole	Marion	Orange	Manatee	Dade	Sarasota	Alachua	Lake	Hillsborough	Total
Nov. 10	.1									.1
24	16.2	.1								16.3
Dec. 1	47.8	.2	3							51
8	105.2		21.5							126.7
15	70.4		15	8.1						93.5
22	34.4		24	7.2	.1					65.7
29	21.2		13	8						42.2
Jan. 5	12.5		22	23.1		.5				58.1
12	11		43	42.2		.1	.1	.1		96.5
19	1.4	.1	32.3	35.8		.1	.1	.2		70
26	.2	.1	15.1	25.5				.1		41
Feb. 2	.1		9.1	19.2				.1		28.5
9	.1	.1	4	13.4	.1			.1		17.8
16		1	7	16.4						24.4
23	1.1	9	7	13.3			12.4			42.8
Mar. 2	.1	26.4		12.1			14.7			53.3
9		35.4		1.2			10.3			46.9
16		25.3		.2			7.5			33
23		21.4					3.8		1	26.2
30		1.8					.1			1.9
Total	321.8	120.9	216	225.7	.2	.7	49	.6	1	935.9

*Weekly shipments of less than .1 carload omitted.

TABLE XXIII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA LETTUCE BY AREAS, SEASON 1928-29.*

Weeks Ending	Area 1†	Area 2†	Area 3†	Area 4†	Other Counties†	Total
Nov. 10	.1					.1
24	16.2	.1				16.3
Dec. 1	47.8	.2	3			51
8	105.2		21.5			126.7
15	70.4		15	8.1		93.5
22	34.4		24	7.2	.1	65.7
29	21.2		13	8		42.2
Jan. 5	12.5		22	23.1	.5	58.1
12	11	.1	43	42.2	.2	96.5
19	1.4	.2	32.3	35.8	.3	70
26	.2	.1	15.1	25.5	.1	41
Feb. 2	.1		9.1	19.2	.1	28.5
9	.1	.1	4	13.4	.2	17.8
16		1	7	16.4		24.4
23	1.1	21.4	7	13.3		42.8
Mar. 2	.1	41.1		12.1		53.3
9		45.7		1.2		46.9
16		32.8		.2		33
23		25.2			1	26.2
30		1.9				1.9
Total	321.8	169.9	216	225.7	2.5	935.9

*Weekly shipments of less than .1 carload omitted.
†See Fig. 13 for counties included.

ESCAROLE

A study of Table XXIV and Fig. 14 leads one to divide the state into only two areas for escarole, with Seminole and Manatee counties, respectively, as the chief centers. Volusia County produced 45 carloads of escarole that year, but it did not figure at all in the production of lettuce. The two areas were in direct competition practically throughout their entire marketing period (Table XXV). Like lettuce, escarole is a cool weather crop, its season ending about April 1.

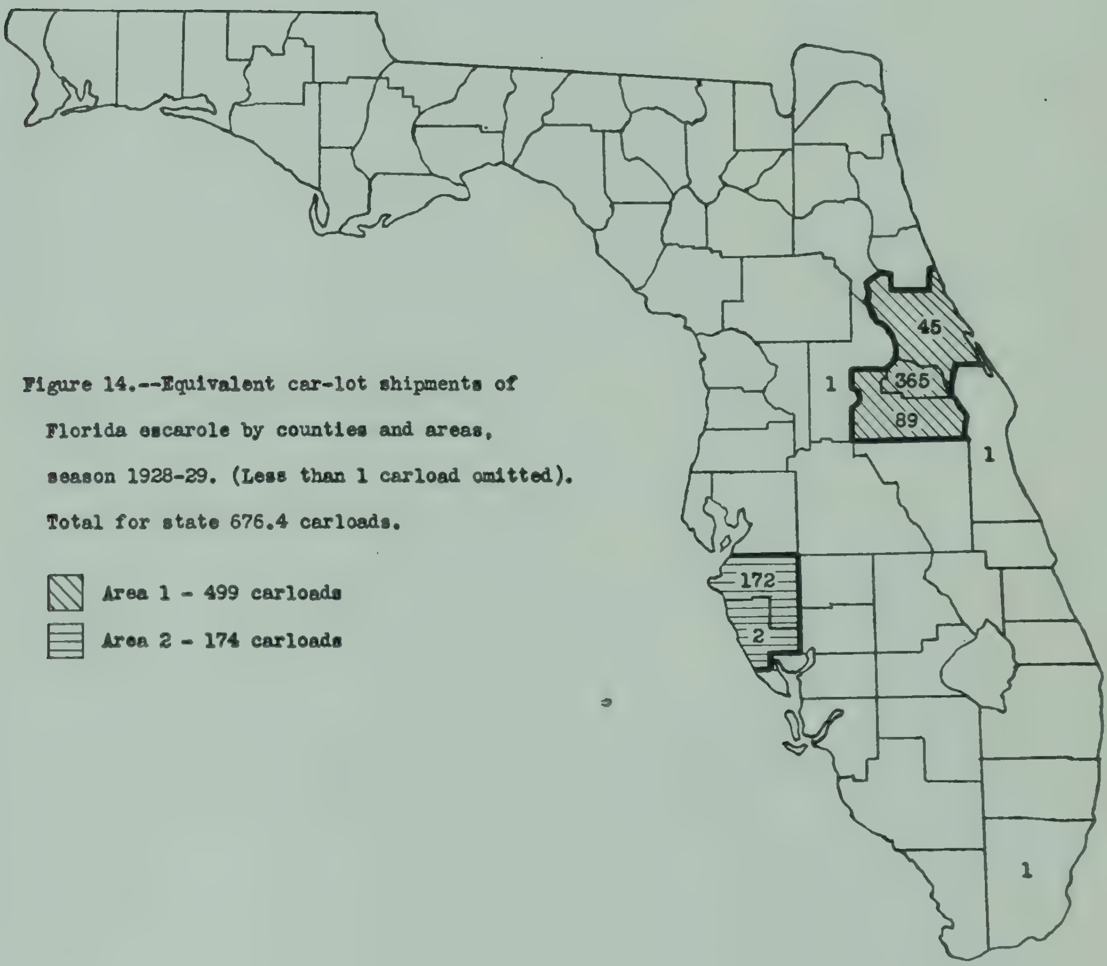

Figure 14.--Equivalent car-lot shipments of Florida escarole by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 676.4 carloads.

TABLE XXIV.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA ESCAROLE BY COUNTIES, SEASON 1928-29*

Weeks Ending	Seminole	Manatee	Volusia	Orange	Dade	Lake	Hillsborough	Sarasota	Brevard	Total
Dec. 8	2									2
15	4	1	2							7
22	34	6	1	4						45
29	29	6	1	10	.1					46.1
Jan. 5	40.1	17	6.3	4	.2					67.6
12	30	11	4	7						52
19	24	28	2	12		1				67
26	26.1	10	7	9						52.1
Feb. 2	22	5	1	5						33
9	22	27	4	9	.1		.1	1		63.2
16	33	18	6	1				1	1	60
23	28	18	8	9						63
Mar. 2	26.2	11	3	13						53.2
9	26	12		3						41
16	9	2		3	.2					14.2
23	7									7
30	3									3
Total	365.4	172	45.3	89	.6	1	.1	2	1	676.4

*Weekly shipments of less than .1 carload omitted.

TABLE XXV.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA ESCAROLE BY AREAS, SEASON 1928-29.*

Weeks Ending	Area 1†	Area 2†	Other Counties†	Total
Dec. 8	2			2
15	6	1		7
22	39	6		45
29	40	6	.1	46.1
Jan. 5	50.4	17	.2	67.6
12	41	11		52
19	38	28	1	67
26	42.1	10		52.1
Feb. 2	28	5		33
9	35	28	.2	63.2
16	40	19	1	60
23	45	18		63
Mar. 2	42.2	11		53.2
9	29	12		41
16	12	2	.2	14.2
23	7			7
30	3			3
Total	499.7	174	2.7	676.4

*Weekly shipments of less than .1 carload omitted.
†See Fig. 14 for counties included.

EGGPLANTS

There are two important areas in Florida growing eggplants (Table XXVII and Fig. 15). They are Area 2 (Manatee) and Area 3 (Ft. Myers). Area 1 (Hernando County), though small, is considered as a separate area due to the fact that it markets most of its eggplants in the fall and early winter not much in competition with the other areas. Area 3 came on the market December 29. It had its peak April 6, just when Area 2 started shipping in carload lots. Then, during the week ending May 4, Area 2 reached a volume of five carloads after having shipped less than carloads by express for 25 weeks, and had its peak on May 18 with 31.7 carloads. The intra-state competition, therefore, is not so noticeable with eggplants as it is with many other crops. Like the other openings revealed, there may be an opportunity in South Florida to ship a greater volume of eggplants in the fall and early winter.

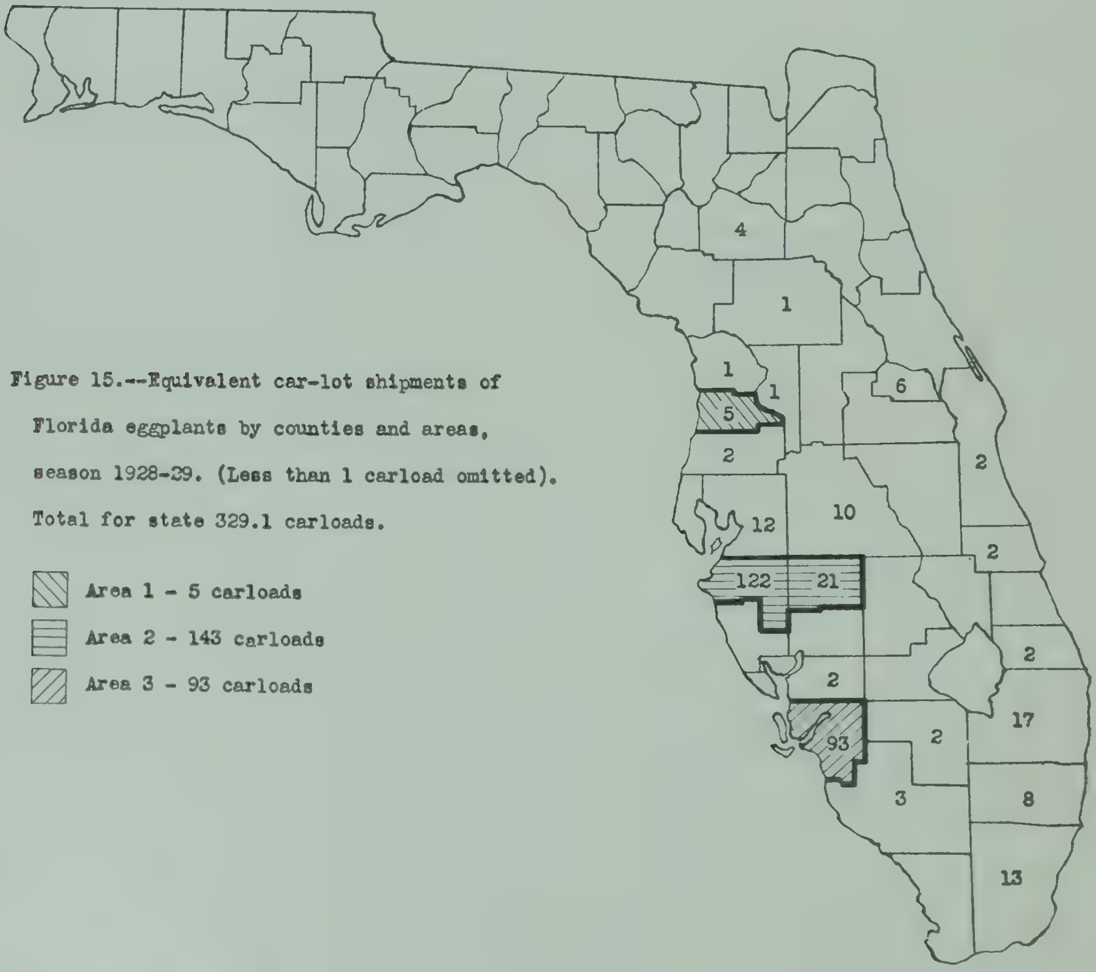
Figure 15.--Equivalent car-lot shipments of Florida eggplants by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 329.1 carloads.

TABLE XXVI.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA EGGPLANTS BY COUNTIES, SEASON 1928-29.*

Weeks Ending		Hernando	Alachua	Citrus	Hardee	Pasco	Brevard	Marion	Volusia	Sumter	Dade	Manatee	Lee	Broward	Palm Beach	Charlotte	Hillsborough	Indian River	Martin	Collier	Hendry	Glades	St. Lucie	Polk	Seminole	Gilchrist	Total
Oct.	6	.4																									.4
	13	.6																									.6
	20	.2	.1																								.3
	27	.1		.1	.2	.1																					.5
Nov.	3	.4	.2	.2	.2	.1																					1.1
	10	.9	.2	.2		.2																					1.5
	17	.6	.2	.2	.2	.5	.1	.1	.1																		2
	24	.6	.8	.2	.6	.6	.1	.1	.2	.1																	3.3
Dec.	1	.4			.2				.1																		.7
	8				.3	.1																					.4
	15	.1			.2	.2	.1				.1																.7
	22	.1			.4						.1	.1															.7
	29				.2		.1				.1		.1														.5
Jan.	5	.1			.2		.1				.1	.1		.1													.7
	12				.2								.1	.1	.1												.5
	19				.1		.2					.1	.4	.1	.1	.3											1.3
	26	.1			.1						.2		.3	.1	.4	.3											1.5
Feb.	2				.2		.2				.1		.7	.1	.3												1.6
	9						.1						.4	.1	.3												.9
	16						.2				.1	.1	.4	.3	.5	.3											1.9
	23						.1				.4	.1	.1	1.1	.9	.1	1										3.8
Mar.	2				.1		.1				.3	.1	1.4	.7	1.3	.4		.1	.1								4.6
	9				.2						.8	.1	4.2	1	1.3	.1	.3	.1		.1							8.2
	16				.4						.6	.1	4.1	.4	1	.4	.5	.1	.1	.1							7.8
	23				.3						.7	.4	5.4	.8	1.2	.2		.2	.1	1							10.3
	30				.2		.1				.9	.5	9.5	.6	1.4	.2		.2	.1	1							14.7
Apr.	6				.3						3.7	1.6	17.1	.1	1.5	.1		.1									24.5
	13				.1						1.2	1.2	8.5	.2	.7			.2	.2	1							13.3
	20				.1						1.8	2.3	7.2	.2	.8			.1	.2		.1						12.8
	27				.3						1.1	2.4	7.7	.2	.8			.2	.1		.1	.1	.1				13.1
May	4				.1						.1	5.1	9.2	.8	.9		.1		.3		.1	.1		.5			17.3
	11				.3						.2	10.4	6.2	.3	.6		.7	.1	.1		.3				.3		19.5
	18				2.4						.2	29.3	4.4	.2	.8		.7	.1	.1		.5	.1		.1	.1		39
	25				3.2						.1	18.9	2.8		.9		1.6	.1	.3					1.3	.1		29.3
June	1				1.5					.3		19.2	1.6		.7		1.1	.1	.2					1.5	.1		26.3
	8				4.4					.1		13.1	.4		.1		2.5				1			2.7	.1		24.4
	15		1		.4			.3		.2		13.9	.6		.1		3.1							.6	3		23.2
	22		2	.1	1.4			.1		.1		1.3	.1		.1			.1						1.7			7
	29				.3					.1		.5	.3											.6	2.2		4
July	6			.1	1.3					.1		.1	.1											.4			2.1
	13			.1	.2							.2												.3			.8
	20				.2							.2												.1		.1	.6
	27			.1								.5												.1			.7
Aug.	3			.1	.1							.4															.6
	10				.1																						.1
Total		4.6	4.5	1.4	21.2	1.8	1.5	.6	.4	1	12.9	122.3	93.3	7.5	16.8	2.4	11.6	1.8	1.9	3.2	2.1	.3	.1	9.9	5.9	.1	329.1

*Weekly shipments of less than .1 carload omitted.

TABLE XXVII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA EGGPLANTS BY AREAS, SEASON 1928-29.*

Weeks Ending	Area 1†	Area 2†	Area 3†	Other Counties†	Total
Oct. 6	.4				.4
13	.6				.6
20	.2			.1	.3
27	.1	.2		.2	.5
Nov. 3	.4	.2		.5	1.1
10	.9			.6	1.5
17	.6	.2		1.2	2
24	.6	.6		2.1	3.3
Dec. 1	.4	.2		.1	.7
8		.3		.1	.4
15	.1	.2		.4	.7
22	.1	.5		.1	.7
29		.2	.1	.2	.5
Jan. 5	.1	.3		.3	.7
12		.2	.1	.2	.5
19		.2	.4	.7	1.3
26	.1	.1	.3	1	1.5
Feb. 2		.2	.7	.7	1.6
9			.4	.5	.9
16		.1	.4	1.4	1.9
23		.1	.1	3.6	3.8
Mar. 2		.2	1.4	3	4.6
9		.3	4.2	3.7	8.2
16		.5	4.1	3.2	7.8
23		.7	5.4	4.2	10.3
30		.7	9.5	4.5	14.7
Apr. 6		1.9	17.1	5.5	24.5
13		1.3	8.5	3.5	13.3
20		2.4	7.2	3.2	12.8
27		2.7	7.7	2.7	13.1
May 4		5.2	9.2	2.9	17.3
11		10.7	6.2	2.6	19.5
18		31.7	4.4	2.9	39
25		22.1	2.8	4.4	29.3
June 1		20.7	1.6	4	26.3
8		17.5	.4	6.5	24.4
15		14.3	.6	8.3	23.2
22		2.7	.1	4.2	7
29		.8	.3	2.9	4
July 6		1.4	.1	.6	2.1
13		.4		.4	.8
20		.4		.2	.6
27		.5		.2	.7
Aug. 3		.5		.1	.6
10		.1			.1
Total	4.6	143.5	93.3	87.7	329.1

*Weekly shipments of less than .1 carload omitted.

†See Fig. 15 for counties included.

ROMAINE

In the shipping of romaine there are conditions similar to those of lettuce; that is, Area 1 (Orange and Seminole counties) came on the market ahead of Area 2, yet Area 2 is farther south (Fig. 16). These two areas competed during the greater part of their shipping seasons. Area 3 (Alachua and Marion counties) did not meet excessive direct competition from the other areas. For all areas, there were weeks of high shipments followed by weeks of low shipments, with no regularity throughout the season. (Tables XXVIII and XXIX.)

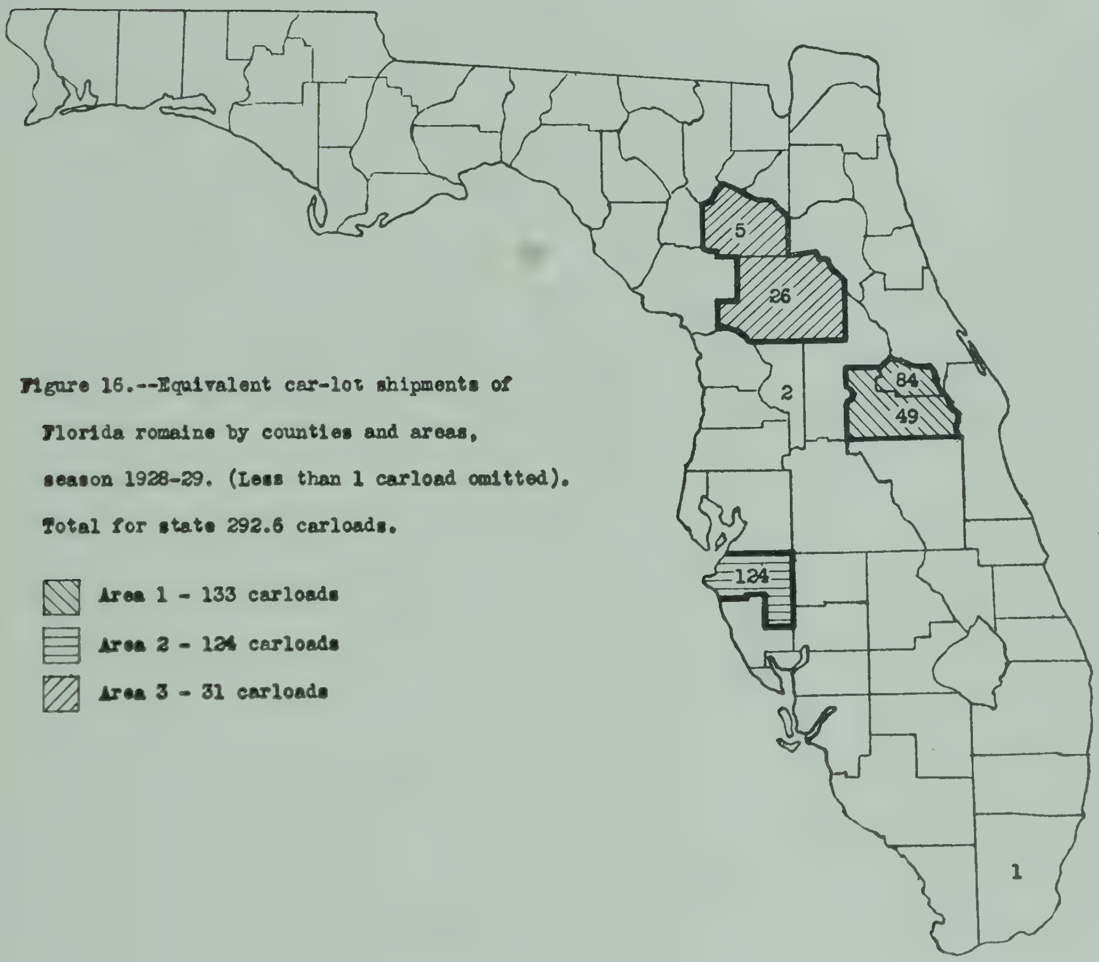

Figure 16.--Equivalent car-lot shipments of Florida romaine by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 292.6 carloads.

TABLE XXVIII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA ROMAINE BY COUNTIES, SEASON 1928-29.*

Weeks Ending		Seminole	Orange	Manatee	Dade	Marion	Sumter	Alachua	Total
Nov.	17	6							6
	24	17							17
Dec.	1	10	1						11
	8	33.3	3.2	9					45.5
	15	5.1	2	3					10.1
	22	5.1	6.1	7					18.2
	29	2.2	1	5	.3				8.5
Jan.	5	2	6	12					20
	12	1.1	2	13.2					16.3
	19	.2	3	21					24.2
	26	.6	14	18.1					32.7
Feb.	2	.1	2	14					16.1
	9		6	3					9
	16		1	3.1	.1				4.2
	23	1	2	10	1				14
Mar.	2			3.1		2	.1		5.2
	9			2		11	2.2	3	18.2
	16			1		6	.1	1	8.1
	23					3			3
	30					4.2		1	5.2
Apr.	13							.1	.1
Total		83.7	49.3	124.5	1.4	26.2	2.4	5.1	292.6

*Weekly shipments of less than .1 carload omitted.

TABLE XXIX.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA ROMAINE BY AREAS, SEASON 1928-29.*

Weeks Ending		Area 1†	Area 2†	Area 3†	Other Counties†	Total
Nov.	17	6				6
	24	17				17
Dec.	1	11				11
	8	36.5	9			45.5
	15	7.1	3			10.1
	22	11.2	7			18.2
	29	3.2	5		.3	8.5
Jan.	5	8	12			20
	12	3.1	13.2			16.3
	19	3.2	21			24.2
	26	14.6	18.1			32.7
Feb.	2	2.1	14			16.1
	9	6	3			9
	16	1	3.1		.1	4.2
	23	3	10		1	14
Mar.	2		3.1	2	.1	5.2
	9		2	14	2.2	18.2
	16		1	7	.1	8.1
	23			3		3
	30			5.2		5.2
Apr.	13			.1		.1
Total		133	124.5	31.3	3.8	292.6

*Weekly shipments of less than .1 carload omitted.
†See Fig. 16 for counties included.

GREEN CORN

The largest volume of green corn was confined to the three counties of Alachua, Bradford and Polk (Table XXX). Alachua County led with a total of 132 equivalent carloads, largely from the town of Alachua. Another heavy shipping center was the town of Lawtey in Bradford County. Area 1 (Polk County), shipped during a period of nine weeks, and its season was practically over before Area 2 was shipping heavily. The peak for Area 2 occurred the week ending June 15 with a slightly decreased movement the following week. (Table XXXI.) Of the grand total from the state of 292.5 equivalent carloads, 242 were shipped from Area 2 (Fig. 17).

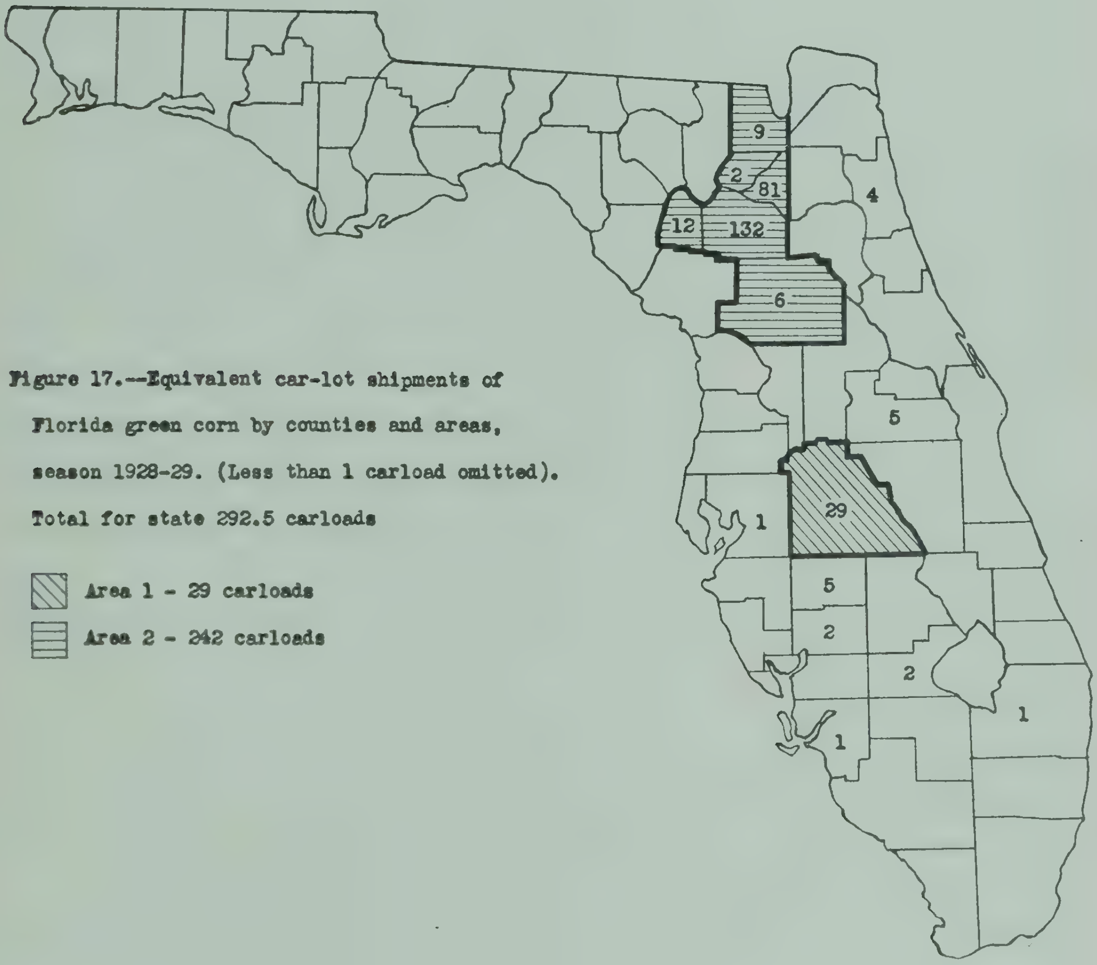

Figure 17.--Equivalent car-lot shipments of Florida green corn by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 292.5 carloads

TABLE XXX.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA GREEN CORN BY COUNTIES, SEASON 1928-29*

Weeks Ending	Palm Beach	St. Johns	Glades	Hillsborough	Hardee	Manatee	Polk	Sumter	DeSoto	Marion	Okeechobee	Citrus	Union	Clay	Levy	Orange	Alachua	Bradford	Hernando	Lee	Baker	Gilchrist	Total
Sept. 8	1																						1
Oct. 27		1																					1
Dec. 15			.1																				.1
Feb. 23				.1																			.1
Mar. 2				.1																			.1
9				.1																			.1
30			.5	.1																			.6
Apr. 6			.3		.4	.1																	.8
13			.1	.1	.5		.1	.1															.9
20			.2	.2	1.7		.4																2.5
27			.1	.3	1.9		5		1	.1	.1												8.5
May 4			.3	.1	.3		3.9		1	.6		.1	.1										6.4
11				.1			4.2			.7		.1		.1	.1	2							7.3
18		2					5.1			.9						3	.2	.5	.1	1			12.8
25		1					7			1.2			.4				.2	2.7					12.5
June 1							2			.7			.2		.2		4.2	8.4					15.7
8		.1					1			1.3			1.1		.1		23.1	15.3			1		43
15										.1							37.1	25.4			2	4	68.6
22										.1							35	20			3	6	64.1
29																	21	6.1			2	2	31.1
July 6										.1							6	3			1		10.1
13																	3.1						3.1
20																	2					.1	2.1
Total	1	4.1	1.6	1.2	4.8	.1	28.7	.1	2	5.8	.1	.2	1.8	.1	.4	5	131.9	81.4	.1	1	9	12.1	292.5

*Weekly shipments of less than .1 carload omitted.

TABLE XXXI.—WEEKLY SUMMARY OF EQUIVALENT SHIPMENTS OF FLORIDA GREEN CORN BY AREAS, SEASON 1928-29.*

Weeks Ending		Area 1†	Area 2†	Other Counties†	Total
Sept.	8			1	1
Oct.	27			1	1
Dec.	15			.1	.1
Feb.	23			.1	.1
Mar.	2			.1	.1
	9			.1	.1
	30			.6	.6
Apr.	6			.8	.8
	13	.1		.8	.9
	20	.4		2.1	2.5
	27	5	.1	3.4	8.5
May	4	3.9	.7	1.8	6.4
	11	4.2	.7	2.4	7.3
	18	5.1	1.6	6.1	12.8
	25	7	4.5	1	12.5
June	1	2	13.5	.2	15.7
	8	1	41.8	.2	43
	15		68.6		68.6
	22		64.1		64.1
	29		31.1		31.1
July	6		10.1		10.1
	13		3.1		3.1
	20		2.1		2.1
Total		28.7	242	21.8	292.5

*Weekly shipments of less than .1 carload omitted.
†See Fig. 17 for counties included.

SQUASHES

Squashes were marketed both in the fall and in the spring (Table XXXII). In some counties (for example Dade County) shipments were started in November in very small amounts, and continued until near the end of May. On the other hand, Marion, Alachua, Levy and other counties had both fall and spring crops.

Each area had direct competition with the other areas (Table XXXIII). Area 1 (Alachua and Marion counties), however, had less competition from the others because of its early fall crop and late spring crop. This area, also, had the highest peak of total shipments. On April 27 it sent 17.1 equivalent carloads, and the total shipments for the area were 66.5 equivalent carloads, mostly in a period of five weeks. Area 2 (Southeast Coast) shipped 64.8 equivalent carloads, but over a period of six months. The territory classed as "other counties" showed a large number of shipments extending from November to the middle of May.

This study reveals that the growing of squashes is widely distributed in the state. Some squashes were sent from the state every week (Table LX).

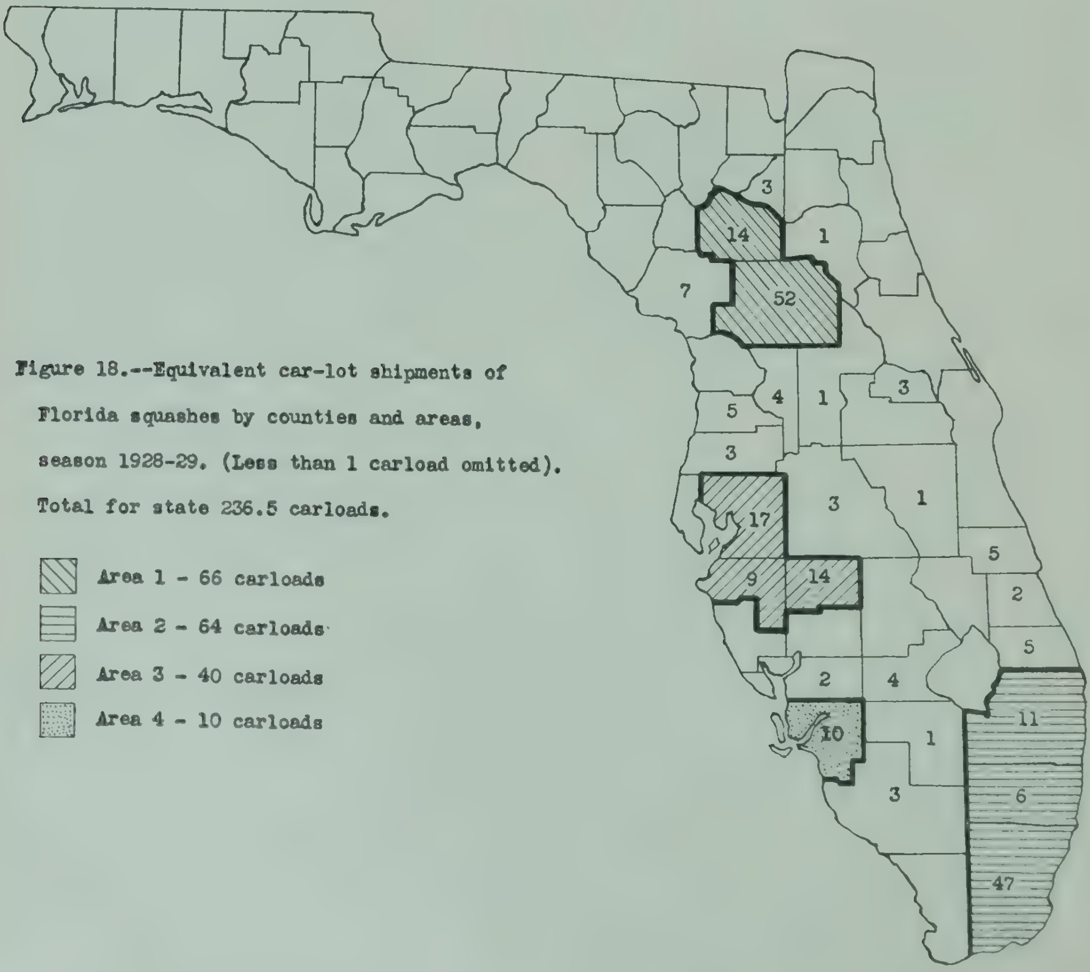

Figure 18.--Equivalent car-lot shipments of Florida squashes by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 236.5 carloads.

TABLE XXXII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA SQUASHES BY COUNTIES, SEASON 1928-29.*

Weeks Ending		Bradford	Alachua	Marion	Levy	Pasco	Dade	Gilchrist	Hardee	Hernando	Union	Manatee	Martin	Lee	Polk	Broward	Charlotte	Palm Beach
Sept.	15	.1																
Oct.	6		.1	.1														
	13		.1	.2														
	20		.1	.4	.1	.1												
	27		.2	.3	.2													
Nov.	3		.2	.7	.5	.1	.2	.1	.1									
	10		.3	.9	.4	.1	.2	.1	.1	1.6	.1							
	17		1.1	.5	.1	.1	.4	.1	.2	1		.1	.1					
	24		.1	.2	.2	.1	.5		.4	.8		.3		.1	.1			
Dec.	1						.4		.1	.2		.4		.1		.1		
	8						.9		.1			.4	.8	.5		.1	.3	.1
	15						.5					.3	.3	.4		.1	.1	.1
	22						.6		.1			.1	.2	.4				.2
	29						.9		.1			.1	.2	.8		.1	.1	.1
Jan.	5						1		.1			.1	.1	.4		.3	.1	.2
	12						1.3					.4		.2		.3		.1
	19						.8					.6		.7		.2		.3
	26						1.1					.5	.2	.3		.5		.5
Feb.	2						2.9					.3	.1	.7		.3		.8
	9						1.9					.6	.3	.6		.4		.9
	16						3.7					.4	.6	.8	.1	.8	.1	1.1
	23						3.2					.4	.5	1		.7		1
Mar.	2						5.4					.2	.3	.8		.6		1.4
	9						4.7		.1			.3		.8		.5	.1	1.1
	16						3.5		1.7			.2	.1	.7	.1	.1	.3	.9
	23			.1		.1	1.6		2.3			.4	.2	.5	.1	.2	.3	.5
	30			.5		.4	2.1		3.6			.8	1.2	.4	.2	.2	.1	.9
Apr.	6			1.5	.1	.4	5.1		2	.1		1.4	.2	.2	.5	.4	.3	.4
	13		.1	5	.4	.5	1.5		1.7	.1		.5			.4	.3		.3
	20	.1	1.7	5.6	.7	.4	2.1		.9	.2		.3			.4	.1		.1
	27	.8	1.4	15.7	1.7	.4	.5		.4			.1			.3			
May	4	.6	1.4	13.3	1.1	.4	.1		.1		.1	.1			.2			.1
	11	1	1.1	6.1	.9		.1	.1			.2				.1			
	18	.3	2	.9	.4		.2			1.1					.1			
	25		2.1	.1	.1					.1					.1			
June	1		.1	.1														
	8	.1	2												.1			
	15	.2																
July	13														.1			
	27			.1														
Aug.	3			.1														
Total		3.2	14.1	52.4	6.9	3.1	47.4	.4	14.1	5.2	.4	9 3	5.4	10.4	2.8	6.3	1.8	11.1

*Weekly shipments of less than .1 carload omitted.

TABLE XXXII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA SQUASHES BY COUNTIES, SEASON 1928-29—Continued.*

Weeks Ending		Indian River	Okeechobee	St. Lucie	Collier	Glades	Highlands	Hendry	Hillsborough	Seminole	Sumter	Putnam	Lake	Citrus	DeSoto	Osceola	St. Johns	Total
Sept.	15																	.1
Oct.	6																	.2
	13																	.3
	20																	.7
	27																	.7
Nov.	3																	1.9
	10																	3.8
	17																	3.7
	24																	2.8
Dec.	1																	1.3
	8																	3.2
	15																	1.8
	22	.1																1.7
	29	.1	.1	.2														2.8
Jan.	5																	2.3
	12			.1														2.4
	19																	2.6
	26			.1	.3													3.5
Feb.	2	.1		.1	.1	.1												5.5
	9			.1	.2	.5												5.5
	16	.1		.1	.6	.2	.1											8.6
	23	.1		.1	.3	.7												8
Mar.	2	.1		.1	.4	.5												9.8
	9		.1	.1	.4	.5		.1										8.8
	16	.1			.2	.2		.3	.5	.1	.1							9.1
	23	.1		.2	.2	.1		.3	1.5	.3	.4	.1						9.5
	30	.7		.2	.1	.1		.3	2.6	1.6	.5	.1	.1					16.7
Apr.	6	1.4		.1		.1		.2	4	.1	.9	.1	.2					19.7
	13	1				.4		.1	2.7	.3	1	.3	.2	.1	.1	.1		17.1
	20	.6				.1			1.5	.2	.5		.2			.1		15.8
	27	.6	.1						2.4	.1	.2		.2			.3		25.2
May	4	.1	.2						1.3	.3	.1		.2			.2	.1	20
	11	.1							.3	.4						.2		10.6
	18								.1							.2		5.3
	25																	2.5
June	1																	.2
	8								.1									2.3
	15																	.2
July	13																	.1
	27																	.1
Aug.	3																	.1
Total		5.3	.5	1.5	2.8	3.5	.1	1.3	17	3.4	3.7	.6	1.1	.1	.1	1.1	.1	236.5

*Weekly shipments of less than .1 carload omitted.

TABLE XXXIII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA SQUASHES BY AREAS, SEASON 1928-29.*

Weeks Ending		Area 1†	Area 2†	Area 3†	Area 4†	Other Counties†	Total
Sept.	15	......	......	......	......	.1	.1
Oct.	6	.2	......	......	......	......	.2
	13	.3	......	......	......	......	.3
	20	.5	......	......	......	.2	.7
	27	.5	......	......	......	.2	.7
Nov.	3	.9	.2	.1	......	.7	1.9
	10	1.2	.2	.1	......	2.3	3.8
	17	1.6	.4	.3	......	1.4	3.7
	24	.3	.5	.7	.1	1.2	2.8
Dec.	1	......	.5	.5	.1	.2	1.3
	8	......	1.1	.5	.5	1.1	3.2
	15	......	.7	.3	.4	.4	1.8
	22	......	.8	.2	.4	.3	1.7
	29	......	1.1	.2	.8	.7	2.8
Jan.	5	......	1.5	.2	.4	.2	2.3
	12	......	1.7	.4	.2	.1	2.4
	19	......	1.3	.6	.7	......	2.6
	26	......	2.1	.5	.3	.6	3.5
Feb.	2	......	4	.3	.7	.5	5.5
	9	......	3.2	.6	.6	1.1	5.5
	16	......	5.6	.4	.8	1.8	8.6
	23	......	4.9	.4	1	1.7	8
Mar.	2	......	7.4	.2	.8	1.4	9.8
	9	......	6.3	.4	.8	1.3	8.8
	16	......	4.5	2.4	.7	1.5	9.1
	23	.1	2.3	4.2	.5	2.4	9.5
	30	.5	3.2	7	.4	5.6	16.7
Apr.	6	1.5	5.9	7.4	.2	4.7	19.7
	13	5.1	2.1	4.9	......	5	17.1
	20	7.3	2.3	2.7	......	3.5	15.8
	27	17.1	.5	2.9	......	4.7	25.2
May	4	14.7	.2	1.5	......	3.6	20
	11	7.2	.1	.3	......	3	10.6
	18	2.9	.2	.1	......	2.1	5.3
	25	2.2	......	......	......	.3	2.5
June	1	.2	......	......	......	......	.2
	8	2	......	.1	......	.2	2.3
	15	......	......	......	......	.2	.2
July	13	......	......	......	......	.1	.1
	27	.1	......	......	......	......	.1
Aug.	3	.1	......	......	......	......	.1
Total		66.5	64.8	40.4	10.4	54.4	236.5

*Weekly shipments of less than .1 carload omitted.
†See Fig. 18 for counties included.

OKRA

The heaviest shipments of okra are made in May, June and July (Table XXXIV), while most other crops are shipped in the fall, winter and early spring. During the season 1928-1929, there were shipments from somewhere in the state every week except for the week ending January 12 (Table LX).

There was direct competition of all the areas with one another (Table XXXV), yet the fall crop for Area 1 (Alachua, Levy and Marion counties) did not encounter serious competition. This was the most important area, shipping approximately 76 percent of the okra from the state for the year. The peak came June 1 with 18.6 carloads and there were 11 weeks of comparatively heavy shipments extending from the middle of May to the middle of July.

Marion was the heaviest shipping county followed by Alachua, Levy and Hillsborough counties, in order. Morriston in Levy County and Plant City in Hillsborough County were the largest shipping points for that year.

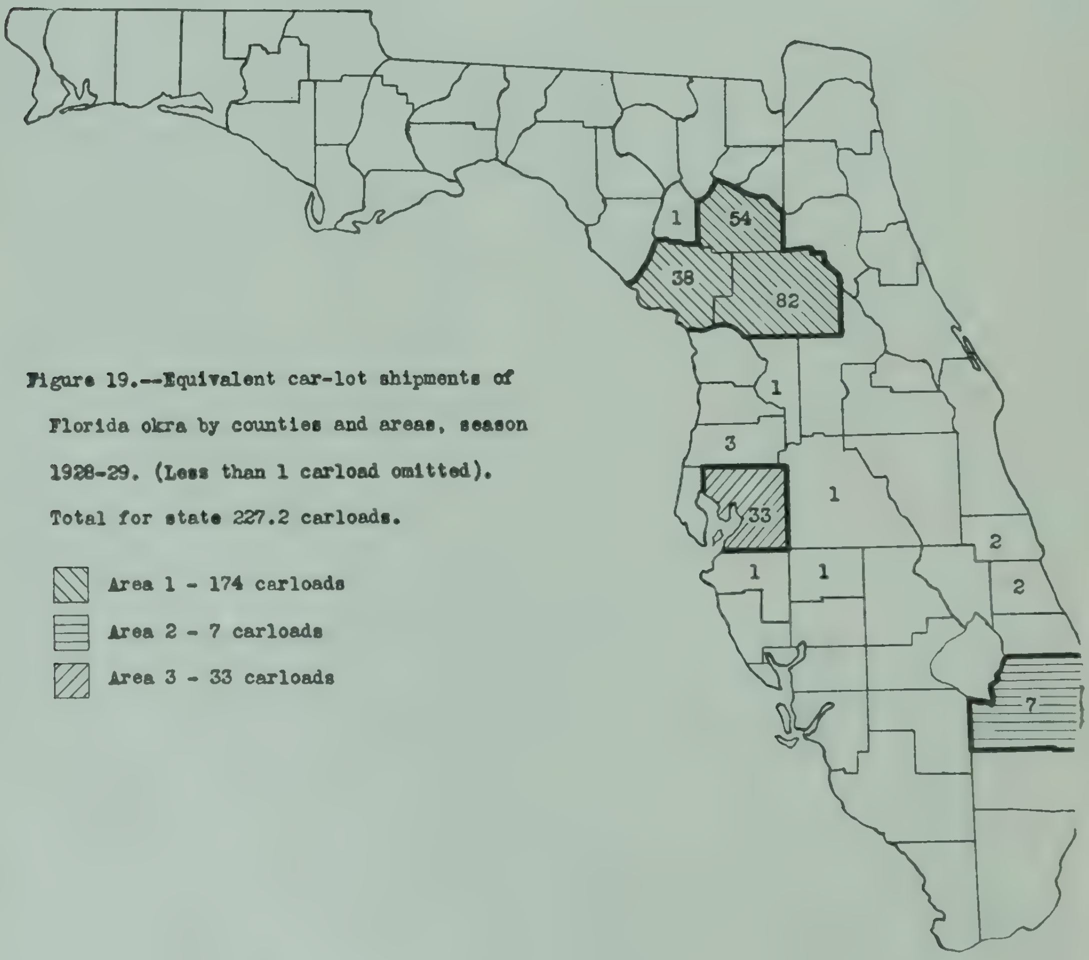

Figure 19.--Equivalent car-lot shipments of Florida okra by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 227.2 carloads.

TABLE XXXIV.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA OKRA BY COUNTIES, SEASON 1928-29.*

Weeks Ending	Alachua	Levy	Marion	Putnam	Gilchrist	Pasco	Sumter	Palm Beach	St. Lucie	Indian River	Hardee	Hillsborough	Hendry	Okeechobee	Glades	Manatee	Polk	Dade	St. Johns	Bradford	Total
Sep. 8	.9	.2	.3	.1																	1.5
15	.4	.1	.4																		.9
22	.4		.3																		.7
29	.5	.1	.4																		1
Oct. 6	.8	.1	.4																		1.3
13	.8	.5	.9		.1	.1															2.4
20	.9	.5	1.4		.2	.3	.1														3.4
27	.5	.8	1	.1	.1	.4	.1														3
Nov. 3	.6	.9	1.3		.1	.2	.1														3.2
10	.3	.7	1.2	.1	.1	.3	.1														2.8
17	.3	.6	.4		.1	.3	.1														1.8
24	2	.2	.3			.1															.8
Feb. 23								.2													.2
Mar. 2								.1													.1
9								.1													.1
16								.1													.1
23								.2													.2
30								.2													.2
Apr. 6								.3	.1												.4
13								.3	.2												.5
20								.4	.1	.1											.6
27		.2	.1					.6	.2	.1	.1	.4									1.7
May 4	.4	1	1.6					1	.3	.1	.1	1.1	.1	.1							5.8
11	1.3	1.7	4.1				.1	1.2	.2	.1	.1	2	.1		.1	.1					11.1
18	2.8	2.7	5.9			.1	.1	.8	.2	.2	.1	3.2	.1	.1	.1	.2					16.6
25	4.3	3.7	8.2			.1	.2	.5	.2	.1	.1	4.7				.2	.1				22.4
June 1	5.8	4.2	8.6	.1	.1	.1	.2	.5	.1	.1	.1	5	.1				.1	.1			25.2
8	4.9	3.3	7.9	.1		.1	.1	.2	.1	.1	.1	3.8					.1		.1		20.9
15	4.6	2.8	7			.1	.1	.1	.1	.1		4.2				.1					19.2
22	4.5	2.9	7.5			.2	.1		.1	.1	.1	4.7				.1	.1	.1		.1	20.6
29	4.3	2.9	6.1			.2			.1	.1	.1	3				.2	.1	.1		.1	17.3
July 6	3.7	2.2	4.6			.2			.1	.1	.1	.5				.1	.1	.1			11.8
13	3.3	1.8	3.5			.1				.1	.1	.2				.1		.1			9.3
20	2.1	1.4	2.9			.1				.1	.1	.1									6.8
27	1.7	.8	2			.1				.1											4.7
Aug. 3	1.2	.5	1.5																		3.2
10	.7	.4	.7																		1.8
17	.5	.1	.6																		1.2
24	.4	.3	.4																		1.1
31	.4	.4	.5																		1.3
Total	53.5	38	82	.5	.8	3.1	1.4	6.8	2.1	1.6	1.2	32.9	.4	.2	.2	1.1	.6	.5	.1	.2	227.2

*Weekly shipments of less than .1 carload omitted.

TABLE XXXV.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA OKRA BY AREAS, SEASON 1928-29.*

Weeks Ending		Area 1†	Area 2†	Area 3†	Other Counties†	Total
Sept.	8	1.4			.1	1.5
	15	.9				.9
	22	.7				.7
	29	1				1
Oct.	6	1.3				1.3
	13	2.2			.2	2.4
	20	2.8			.6	3.4
	27	2.3			.7	3
Nov.	3	2.8			.4	3.2
	10	2.2			.6	2.8
	17	1.3			.5	1.8
	24	.7			.1	.8
Feb.	23		.2			.2
Mar.	2		.1			.1
	9		.1			.1
	16		.1			.1
	23		.2			.2
	30		.2			.2
Apr.	6		.3		.1	.4
	13		.3		.2	.5
	20		.4		.2	.6
	27	.3	.6	.4	.4	1.7
May	4	3	1	1.1	.7	5.8
	11	7.1	1.2	2	.8	11.1
	18	11.4	.8	3.2	1.2	16.6
	25	16.2	.5	4.7	1	22.4
June	1	18.6	.5	5	1.1	25.2
	8	16.1	.2	3.8	.8	20.9
	15	14.4	.1	4.2	.5	19.2
	22	14.9		4.7	1	20.6
	29	13.3		3	1	17.3
July	6	10.5		.5	.8	11.8
	13	8.6		.2	.5	9.3
	20	6.4		.1	.3	6.8
	27	4.5			.2	4.7
Aug.	3	3.2				3.2
	10	1.8				1.8
	17	1.2				1.2
	24	1.1				1.1
	31	1.3				1.3
Total		173.5	6.8	32.9	14	227.2

*Weekly shipments of less than .1 carload omitted.
†See Fig. 19 for counties included.

GREEN PEAS

There were 30 counties shipping .1 carload or more of green peas to the northern markets during the year under study (Table XXXVI). Not any of these counties shipped large amounts. The most shipped by individual counties was 28.2 equivalent carloads from Palm Beach, 16.9 from Hardee, and 10.7 from Indian River.

For this commodity the state has been divided into five areas (Table XXXVII). A study of Table XXXVII and Fig. 20 reveals that so far as areas shipping at the same time are concerned there is direct competition among them all. The late spring crop for Area 2 (Hardee, Hillsborough, Polk and Manatee counties) did not appear to have serious competition. Area 1 (Alachua-Marion) experienced three minor peaks during its season.

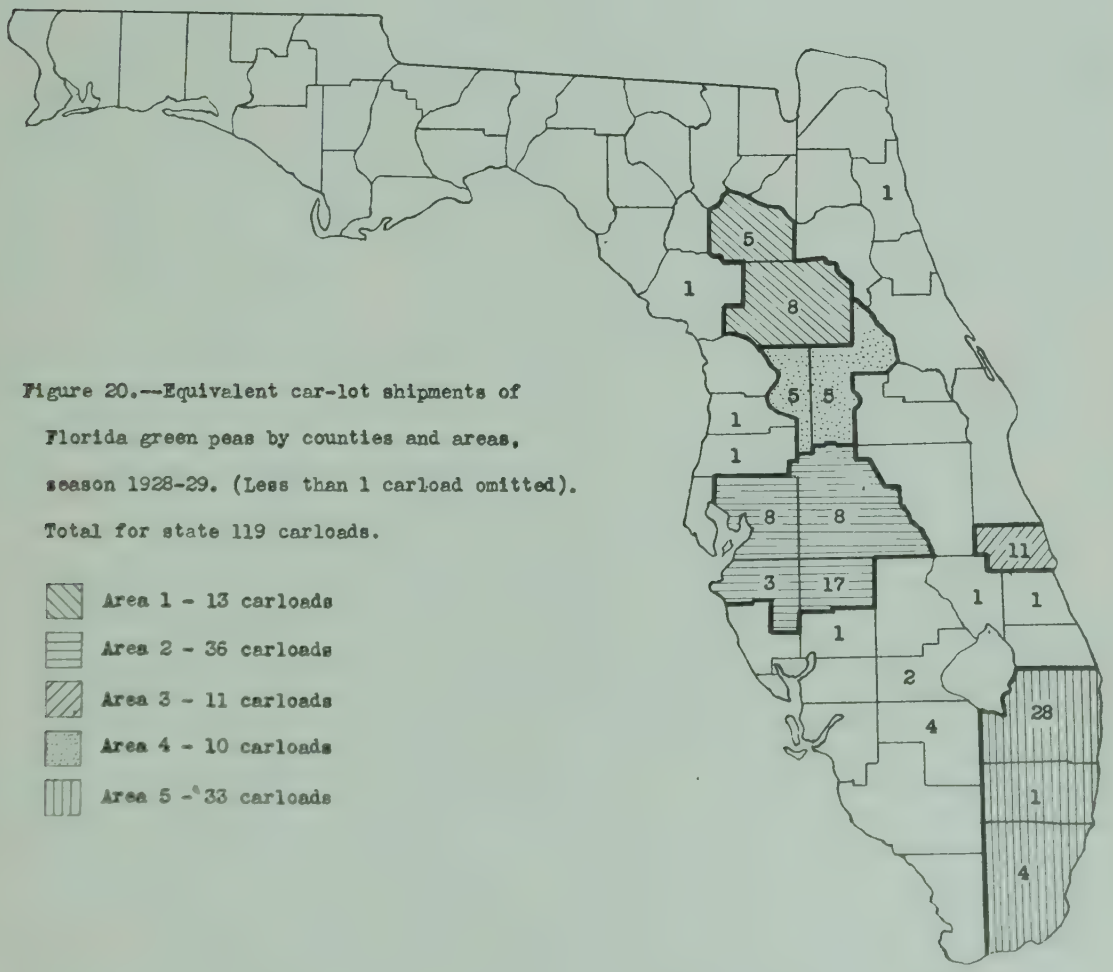

Figure 20.—Equivalent car-lot shipments of Florida green peas by counties and areas, season 1928-29. (Less than 1 carload omitted). Total for state 119 carloads.

TABLE XXXVI.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA GREEN PEAS BY COUNTIES, SEASON 1928-29.*

Weeks Ending		Marion	Alachua	Hardee	Hillsborough	Manatee	Osceola	St Johns	Sarasota	Indian River	Lake	Polk	Sumter	Broward	DeSoto	Palm Beach	Dade	Hendry	St. Lucie	Orange	Glades	Collier	Okeechobee	Pasco	Highlands	Hernando	Martin	Union	Bradford	Levy	Charlotte	Total
Oct.	13	.2																														.2
	27	.2																														.2
Nov.	3	.1	.1																													.2
	10	.1	.1																													.2
	17	.2	.1																													.3
	24	.5	.6	.1																												1.2
Dec.	1	.1	.5																													.6
	8		.1	.2	.1	.3	.1	.1	.1																							1
	15			.1	.1				.1	.2																						.5
	22		.2	.2	.1	.1					.1																					.7
	29		.1								.1	1	.1																			1.3
Jan.	5		.1	.4	.1					.2			.1	.3	.1	.2																1.5
	12			.3		.1				.2		.3	.1	.1		.1	.1	.6	.1													2
	19			.3	.1	.1				.2	.1	.1	.1	.2		.3		.9	.1													2.5
	26			1.2		.2				1.2	.3		.2	.1	.1	3.4	.3	.5	.2	.1												7.8
Feb.	2	.2	.1	1.6	.1	.5				1.8	1	1.2	.8	.1	.2	6.7	1.3	.6	.2	.2												16.6
	9	.1		1.8		.7				5	1	1.5	1.1	.1	.1	5.3	.1	1	.3		.2											18.3
	16	.2		1.6	.1	.5				.3	.6	.2	.8			6.3	.2		.1		.6	.1	1	.1								12.7
	23	.3		1.6	.3	.4				.4	.7	.1	.4			1.7	1.8		.1		.2				.1							8.1
Mar.	2	.2		.1	.1					.6	.6	.1	.1			.9	.4	.4	.1		.3			.1								4
	9	.4	.2	.1						.3	.2	.1		.1		1.1	.1	.1														2.7
	16	.4	.3			.1				.1		.1				.6	.1	.1			.1											1.9
	23	1.1	.4					1		.1	.1		.1			.2		.1	.1							.7	.2	.3				4.4
	30	.6	.4							.1			.1															.1				1.3
Apr.	6	.1	.1											.2							.3								.2			.9
	13			.2								.6				.1					.1											1
	20			.6	.2							.6				.1					.2											1.7
	27	.1		2.4	1.3							.7	.1			.1					.2											4.9
May	4	.1		2.3	1.7							.6	.1		.1	.6					.2			.1								5.8
	11	.3		1	1.7						.2	.6	.4		.1	.2								.2		.1				.1		4.9
	18	1.2	.7	.7	1.8						.1	.5	.2			.1								.2						.2		5.7
	25	.7	.6	.1								.1												.1					.1	.3	.1	2.1
June	1	.5	.1													.1												.1	.1	.1		1
	8		.2												.1	.1																.4
	22		.1																													.1
July	13																						.2									.2
	20		.1																													.1
Total		7.9	5.2	16.9	7.8	3	.1	1.1	.2	10.7	5.1	8.4	4.8	1.2	.8	28.2	4.4	4.3	1.3	.3	2.4	.1	1.2	.8	.1	.8	.2	.5	.4	.7	.1	119

*Weekly shipments of less than .1 carload omitted.

TABLE XXXVII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA GREEN PEAS BY AREAS, SEASON 1928-29.*

Weeks Ending	Area 1†	Area 2†	Area 3†	Area 4†	Area 5†	Other Counties†	Total
Oct. 13	.2						.2
27	.2						.2
Nov. 3	.2						.2
10	.2						.2
17	.3						.3
24	1.1	.1					1.2
Dec. 1	.6						.6
8	.1	.6				.3	1
15		.2	.2			.1	.5
22	.2	.4		.1			.7
29	.1	1		.2			1.3
Jan. 5	.1	.5	.2	.1	.5	.1	1.5
12		.7	.2	.1	.3	.7	2
19		.6	.2	.2	.5	1	2.5
26		1.4	1.2	.5	3.8	.9	7.8
Feb. 2	.3	3.4	1.8	1.8	8.1	1.2	16.6
9	.1	4	5	2.1	5.5	1.6	18.3
16	.2	2.4	.3	1.4	6.5	1.9	12.7
23	.3	2.4	.4	1.1	3.5	.4	8.1
Mar. 2	.2	.3	.6	.7	1.3	.9	4
9	.6	.2	.3	.2	1.3	.1	2.7
16	.7	.2	.1		.7	.2	1.9
23	1.5		.1	.2	.2	2.4	4.4
30	1		.1	.1		.1	1.3
Apr. 6	.2				.2	.5	.9
13		.8			.1	.1	1
20		1.4			.1	.2	1.7
27	.1	4.4		.1	.1	.2	4.9
May 4	.1	4.6		.1	.6	.4	5.8
11	.3	3.3		.6	.2	.5	4.9
18	1.9	3		.3	.1	.4	5.7
25	1.3	.2				.6	2.1
June 1	.6				.1	.3	1
8	.2				.1	.1	.4
22	.1						.1
July 13						.2	.2
20	.1						.1
Total	13.1	36.1	10.7	9.9	33.8	15.4	119

*Weekly shipments of less than .1 carload omitted.
†See Fig. 20 for counties included.

MINOR CROPS

TABLE XXXVIII.—Total Equivalent Car-lot Shipments of Florida Minor Truck Crops, Season 1928-29

Crop	Equivalent Carloads	Crop	Equivalent Carloads
Cauliflower	30	Grapes	17.3
Avocados	22.6	Pineapples	11.4
Cantaloupes	17.8	Blueberries	11

CAULIFLOWER

There were three rather definite sections in the production of cauliflower (Table XXXIX). The northern section, consisting of Putnam and St. Johns counties, was the leading area with a total of 22.6 equivalent carloads for the year.

TABLE XXXIX.—Weekly Summary of Equivalent Car-lot Shipments of Florida Cauliflower by Counties, 1929.*

Weeks Ending	Seminole	Manatee	Volusia	Dade	Orange	Putnam	St. Johns	Hernando	Total
Jan. 5	.1								.1
12	.5	1.4	.1						2
19	.8	2.1	.1	.3	1.1	1.1	3		8.5
26	.2	.4	.1		.1	5	10		15.8
Feb. 2						1.2	2		3.2
9						.1			.1
16						.1			.1
23							.1		.1
Mar. 2								.1	.1
Total	1.6	3.9	.3	.3	1.2	7.5	15.1	.1	30

*Weekly shipments of less than .1 carload omitted.

AVOCADOS

Avocados were confined almost entirely to Dade County (Table XL), although the west coast had shipments of less than .1 carload per week. Dade County alone shipped 22.5 equivalent carloads that season.

TABLE XL.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA AVOCADOS BY COUNTIES, SEASON 1928-29.*

Weeks Ending	Dade	Palm Beach	Total
Sept. 8	1.1		1.1
15	1.2		1.2
22	1.8	.1	1.9
29	1.2		1.2
Oct. 6	1.4		1.4
13	1.1		1.1
20	1.1		1.1
27	.8		.8
Nov. 3	1		1
10	.8		.8
17	.6		.6
24	.7		.7
Dec. 1	.3		.3
8	.6		.6
15	.6		.6
22	.2		.2
June 22	.1		.1
29	.3		.3
July 6	.5		.5
13	.6		.6
20	.7		.7
27	.8		.8
Aug. 3	.7		.7
10	1		1
17	.8		.8
24	1.1		1.1
31	1.4		1.4
Total	22.5	.1	22.6

*Weekly shipments of less than .1 carload omitted.

CANTALOUPES

Marion was the only county shipping cantaloupes to any appreciable amount (Table XLI). Sectional competition in Florida was of minor importance with this crop.

TABLE XLI.—Weekly Summary of Equivalent Car-lot Shipments of Florida Cantaloupes by Counties, 1929.*

Weeks Ending	Marion	Sumter	Hillsborough	Alachua	Bradford	Total
May 11	2.3	.4				2.7
18	4.3		.1			4.4
25	3.8	.2				4
June 1	2.5	.1		.1	.1	2.8
8	2.8			.2	.1	3.1
15	.2					.2
22	.5					.5
29	.1					.1
Total	16.5	.7	.1	.3	.2	17.8

*Weekly shipments of less than .1 carload omitted.

GRAPES

Grapes were shipped from Central and West Florida in small amounts. Lake County shipped 11.7 equivalent carloads and Washington County shipped four carloads. Marketing seasons of these counties did not overlap (Table XLII).

TABLE XLII.—Weekly Summary of Equivalent Car-lot Shipments of Florida Grapes by Counties, 1929.*

Weeks Ending	Pasco	Lake	Marion	Citrus	Washington	Total
June 8	.1	.4				.5
15	.1	2.2				2.3
22	.2	4	.4			4.6
29	.1	5.1	.4			5.6
July 6			.2	.1		.3
13					2	2
20					1	1
27					1	1
Total	.5	11.7	1	.1	4	17.3

*Weekly shipments of less than .1 carload omitted.

PINEAPPLES

Pineapples were produced formerly in much larger quantities in Florida than at present. Foreign competition and plant diseases were the principal causes for the decline of this industry. Only 11.4 equivalent carloads were shipped in 1928-29 from the state (Table XLIII).

TABLE XLIII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA PINEAPPLES BY COUNTIES, SEASON 1928-29.*

Weeks Ending	Charlotte	Palm Beach	St. Lucie	Martin	Dade	Total
Dec. 8	.1					.1
15		.1				.1
May 25		2				2
June 1		2	1			3
15		1	1	.1	1	3.1
22			1	.1		1.1
29	.1		1.1	.2		1.4
July 6	.1					.1
13	.1					.1
20	.1					.1
27	.1					.1
Aug. 17				.1		.1
31				.1		.1
Total	.6	5.1	4.1	.6	1	11.4

*Weekly shipments of less than .1 carload omitted.

BLUEBERRIES

Only West Florida shipped blueberries during the year under study. Okaloosa was the only county shipping in car lots (Table XLIV). Express movement was not obtained.

TABLE XLIV.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF FLORIDA BLUEBERRIES BY COUNTIES, 1929.*

Weeks Ending	Okaloosa
June 22	2
29	1
July 6	4
13	2
20	1
Aug. 3	1
Total	11

*Weekly shipments of less than .1 carload omitted.

MISCELLANEOUS CROPS

TABLE XLV.—TOTAL EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA MISCELLANEOUS TRUCK CROPS, SEASON 1928-29.

Crop	Equivalent Carloads	Crop	Equivalent Carloads
Carrots	8.8	Dasheens	.2
Chicory	7	Endive	.1
Onions	5.3	Boctoy	.1
Parsley	5.2	Kale	.1
Beets	4.4	Mangoes	x
Turnips	2.4	Pumpkins	x
Broccoli	2.3	Mustard	x
Mixed greens	2	Swiss chard	x
Chinese cabbage	1.9	Kohlrabi	x
Collards	1	Artichokes	x
Sorrel	1	Blackberries	x
Spinach	.4	Chayotes	x
Papayas	.3	Parsnips	x
Radishes	.2	Brussels sprouts	x

In Table XLV is listed the group of miscellaneous crops shipped from the state, shipments of no one of which equaled 10 carloads during the year. The shipments of each miscellaneous crop from each county by the week for the season 1928-29, are shown in Tables XLVI to LVI, inclusive.

TABLE XLVI.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA CARROTS BY COUNTIES, 1929.*

Weeks Ending		Dade	Manatee	Seminole	St. Johns	Alachua	Palm Beach	Total
Jan.	19	.2	.1					.3
Feb.	2	.3		.1				.4
	9	.1						.1
	16		.1					.1
Mar.	9				.1			.1
	16	.1				.1		.2
	23						1	1
	30					1	1	2
Apr.	6				1			1
	13				1			1
	20	.4						.4
	27				2	.1		2.1
June	15	.1						.1
Total		1.2	.2	.1	4.1	1.2	2	8.8

*Weekly shipments of less than .1 carload omitted.

TABLE XLVII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA CHICORY BY COUNTIES, 1929.*

Weeks Ending	Orange	Seminole	Total
Jan. 19	3		3
26	3		3
Mar. 30		1	1
Total	6	1	7

*Weekly shipments of less than .1 carload omitted.

TABLE XLVIII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA ONIONS BY COUNTIES, 1929.*

Weeks Ending	St. Johns	Glades	Dade	Marion	Okeechobee	Palm Beach	Putnam	Manatee	Lee	Total
Mar. 2	.1									.1
Apr. 20		1								1
27			.2	.1						.3
May 4				.1						.1
11					.1	1.2				1.3
18				.1		.1	.1			.3
25							.1			.1
June 1				.1						.1
15								1		1
22									1	1
Total	.1	1	.2	.4	.1	1.3	.2	1	1	5.3

*Weekly shipments of less than .1 carload omitted.

TABLE XLIX.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA PARSLEY BY COUNTIES, SEASON 1928-29.*

Weeks Ending		Seminole	Lake	Total
Dec.	22	.1		.1
	29	.1		.1
Jan.	5	.1		.1
	12	.3		.3
	19	.2	.1	.3
	26	.4	.1	.5
Feb.	2	.3		.3
	9	.2	.1	.3
	16	.4	.1	.5
	23	.4	.1	.5
Mar.	2	.3		.3
	9	.2		.2
	16	.4		.4
	23	.3		.3
	30	.2		.2
Apr.	6	.3		.3
	13	.2		.2
	20	.2		.2
	27	.1		.1
Total		4.7	.5	5.2

*Weekly shipments of less than .1 carload omitted.

TABLE L.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA BEETS BY COUNTIES, 1929.*

Weeks Ending		Dade	Glades	Seminole	Manatee	Total
Jan.	12	.2	.1	.1		.4
	19	.2		.1		.3
	26			.1	.1	.2
Feb.	2			.2	.1	.3
	9			.1	.1	.2
	16			.1	.1	.2
	23			.1		.1
Mar.	2			.1	.3	.4
	9			.1	1.1	1.2
	16	.5		.1		.6
	23			.1		.1
	30	.1		.1		.2
Apr.	27	.1				.1
May	4	.1				.1
Total		1.2	.1	1.3	1.8	4.4

*Weekly shipments of less than .1 carload omitted.

TABLE LI.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA TURNIPS BY COUNTIES, 1929.*

Weeks Ending	Hardee	Bradford	Levy	Osceola	Total
Feb. 9	1				1
23	1				1
Mar. 2		.1			.1
9			.1		.1
May 18				.1	.1
25				.1	.1
Total	2	.1	.1	.2	2.4

*Weekly shipments of less than .1 carload omitted.

TABLE LII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA BROCCOLI BY COUNTIES, 1929.*

Weeks Ending	Dade	Sarasota	Seminole	Sumter	Martin	Total
Jan. 12	.2	.2				.4
19	.1		.1			.2
26		.2	.1			.3
Feb. 2		.1				.1
9				.1		.1
16	.3					.3
Mar. 2				.2		.2
9				.2		.2
16				.2		.2
23				.1	.1	.2
30					.1	.1
Total	.6	.5	.2	.8	.2	2.3

*Weekly shipments of less than .1 carload omitted.

MIXED GREENS

The term "mixed greens" applies to those shipments which went out billed as greens. There were other commodities shipped which are used as greens, such as collards, and most of the turnips, but the ones going out as greens were often mixed and so could not be definitely named otherwise. The leading shipments of this kind were from Polk and Seminole counties (Table LIII).

TABLE LIII.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA MIXED GREENS BY COUNTIES, SEASON 1928-29.*

Weeks Ending	Polk	Seminole	Osecola	Total
Dec. 22	.1			.1
29	.2			.2
Jan. 5	.1			.1
12	.1			.1
19	.1			.1
26	.1			.1
Feb. 9	.1			.1
23	.1	.2		.3
Mar. 2	.1	.5	.1	.7
9	.1			.1
16	.1			.1
Total	1.2	.7	.1	2

*Weekly shipments of less than .1 carload omitted.

TABLE LIV.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA CHINESE CABBAGE BY COUNTIES, SEASON 1928-29.*

Weeks Ending	Osceola
Nov. 3	.1
Dec. 1	.1
8	.1
15	.1
22	.1
29	.1
Jan. 5	.1
12	.2
19	.3
26	.1
Feb. 2	.1
9	.1
16	.2
23	.1
Mar. 2	.1
Total	1.9

*Weekly shipments of less than .1 carload omitted.

COLLARDS

Although many home gardens of Florida contain collards the only large shipment discovered was one carload from Palm Beach County (Table LV).

TABLE LV.—WEEKLY SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF FLORIDA COLLARDS BY COUNTIES, 1929.*

Weeks Ending	Palm Beach
Feb. 2	1
Total	1

*Weekly shipments of less than .1 carload omitted.

SORREL

One carload of sorrel for greens was shipped from the state during the year (Table LVI).

In the above named crops falling both in the minor and miscellaneous classes it is unlikely that the intra-state competition is worthy of consideration. Some of them do have more than one definite section in which they are produced as shown by their tables, but their total production is relatively small. With a few of these commodities which are peculiarly adapted to subtropical climate there may be possibilities for expansion for a limited number of growers.

TABLE LVI.—WEEKLY SUMMARY OF CAR-LOT SHIPMENTS OF FLORIDA SORREL BY COUNTIES, 1929.

Weeks Ending	Orange
March 30	1
Total	1

SUMMARY

A summary of the total shipments of each crop studied from each county for the season 1928-29 is given in Table LVII, and Table LVIII groups the most important of these crops shipped out that year from each county. There were 17 counties which shipped more than 1,000 carloads of the various truck crops during the year, 21 other counties shipped between 100 and 1,000 carloads, and the remaining counties shipped less than 100 carloads. Seminole County led all others in total shipments, amounting to 7,585.3 equivalent carloads, 85 percent of which were celery. The next four crops in Seminole County, in the order of their importance, were escarole, lettuce, peppers and cabbage.

The five next highest counties were:

Dade, with 4,738.1 total equivalent carloads and with tomatoes amounting to 81 percent of the total from the county. Peppers, cabbage and green beans were the next three leading crops.

Manatee, with a total of 3,537.7 equivalent carloads, with celery and tomatoes of about equal importance and representing two-thirds of the total shipments. Lettuce, cabbage and escarole were also important.

St. Johns, with a total of 3,400.7 equivalent carloads, 91 percent of which were early white potatoes.

Alachua, with a total of 2,965.3 equivalent carloads, of which 49 percent were watermelons, 14 percent were cucumbers, and cabbage, beans, and early white potatoes followed in the order named.

Marion, with a total of 2,704.7 equivalent carloads, where the leading crops were watermelons 31 percent, green beans 20 percent, and tomatoes 18 percent.

It is very likely that some of these counties do not remain in the same order from year to year but that some shifting of position occurs. It is easy to understand how a heavy potato crop could enable St. Johns County to displace Manatee, and Marion may sometimes ship more than Alachua. Probably there is other shifting, but on the whole these two tables give a clear picture of each county and its relative place in the shipments of the truck crops of the state and the names of those crops as well as the relative importance of the crops to each county.

A summary of the total shipments per week of all truck crops from each county is given in Table LIX. There were shipments moving from the state every week in the year, although only one county (Dade) actually made shipments every week as large as .1 equivalent carload. Alachua County missed shipping on the week ending December 15 and Marion County did not ship for a period of five weeks. All other counties had vacant periods longer than five weeks.

TABLE LVII. — SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF TRUCK CROPS BY COUNTIES, SEASON 1928-29.

	Alachua	Baker	Bradford	Brevard	Broward	Charlotte	Citrus	Clay	Collier	Columbia	Dade	DeSoto	Dixie	Duval	Escambia	Flagler	Gilchrist	Glades	Hamilton
Watermelons	1,421		164				45	4	9	78	.2	10	3				1,236		229
Celery				32				.1											
Tomatoes	18.3		2.4	17.9	540.9	15.7	.1	.1	202.3		3,817.6							4.2	
Green beans*	280.9		100.3	12.5	917.6	.1	.3	.7	1.7		178.8	.4				.1	.3	60.5	
Early white potatoes	260.2		9.7	5.7	4.8	6		254			70.3	24		3.6	46	396.4		2.3	
Cabbage	290.3		4	3	71		1	9.5	2		205.5	5			5	154		63.1	
Cucumbers	400.4		3.2	1.1	11.3	.6	.2		3.3	27	3.5	1.4		.5			.7	.6	3
Peppers	29		3.5	44	700.7	15.8		16.1	19.1		367.1	.3						.2	
Strawberries	.4		399.7					2.3			.7	.1							
Lettuce	49										.2								
Escarole				1							.6								
Eggplants	4.5			1.5	7.5	2.4	1.4		3.2		12.9						.1	.3	
Romaine	5.1										1.4								
Green corn	131.9	9	81.4				.2	.1				2					12.1	1.6	
Squashes	14.1		3.2		6.3	1.8	.1		2.8		47.4	.1					.4	3.5	
Okra	53.5		.2								.5						.8	.2	
Green peas	5.2		.4		1.2	.1			.1		4.4	.8						2.4	
Cauliflower											.3								
Avocados											22.5								
Cantaloupes	.3		.2																
Grapes							.1												
Pineapples						.6					1								
Blueberries																			
Carrots	1.2										1.2								
Chicory																			
Onions											.2							1	
Parsley																			
Beets											1.2							.1	
Turnips			.1																
Broccoli											.6								
Mixed greens																			
Chinese cabbage																			
Collards																			
Sorrel																			
Spinach																			
Dasheens														.1					
Kale																			
Total	2,965.3	9	772.3	118.7	2,261.3	43.1	48.4	286.9	243.5	105	4,738.1	44.1	3	4.2	51	550.5	1,250.4	140	232

*Green beans includes lima beans.

TABLE LVII.—SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF TRUCK CROPS BY COUNTIES, SEASON 1928-29—Continued.

	Hardee	Hendry	Hernando	Highlands	Hillsborough	Holmes	Indian River	Jackson	Lafayette	Lake	Lee	Levy	Mad:son	Manatee	Marion	Martin	Monroe	Okaloosa	Okeechobee
Watermelons	54	21	4	26	38	170	3	714	39	1,510	43	646	9	26	850				2
Celery				8	2					3				1,209.6	1				
Tomatoes	141.3	59.6	9		238.1		404.6			5.5	86.3	.8		1,138.8	484.3	73.8	30		104 7
Green beans*	52.7	112.3	12 6	.4	131.8		271.5			43.6	12.5	36 4		37.6	538.3	184.5	1		70 7
Early white potatoes	15.6	20	3	6	34.5		48.4			1 2	30.4	3		16.2	16.1	16.1			11
Cabbage	14		.1	1	53		1			162		1		194.2	401.2				2
Cucumbers	425.2	8	3.5		67.3		6			42.6	19.8	431 1		43.2	91.7	1.1			.6
Peppers	46.8	6.9	.7	.2	238.9		46.7			1.5	97.2	.1		179.1	8.4	18.9			6.6
Strawberries	280.1		2.2		1,010.6		1.7							28.1					
Lettuce					1					.6				225.7	120.9				
Escarole					.1					1				172					
Eggplants	21.2	2.1	4.6		11.6		1.8				93.3			122.3	.6	1.9			
Romaine														124.5	26.2				
Green corn	4.8		.1		1.2						1	.4		.1	5.8				.1
Squashes	14.1	1.3	5.2	.1	17		5.3			1.1	10.4	6 9		9.3	52.4	5.4			.5
Okra	1.2	.4			32.9		1.6					38		1.1	82				.2
Green peas	16.9	4.3	.8	.1	7.8		10.7			5.1		.7		3	7.9	.2			1.2
Cauliflower			.1											3.9					
Avocados																			
Cantaloupes					.1										16.5				
Grapes										11.7					1				
Pineapples																.6			
Blueberries																		11	
Carrots														.2					
Chicory																			
Onions											1			1	.4				.1
Parsley										.5									
Beets														1.8					
Turnips	2											.1							
Broccoli																.2			
Mixed greens																			
Chinese cabbage																			
Collards																			
Sorrel																			
Spinach																			
Dasheens																			
Kale																			
Total	1,089.9	235.9	45.9	41 8	1,885.9	170	802.3	714	39	1.789.4	394.9	1,164 5	9	3,537.7	2,704 7	302.7	31	11	199.7

*Green beans includes lima beans.

TABLE LVII.—SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF TRUCK CROPS BY COUNTIES, SEASON 1928-29—Continued.

	Orange	Osceola	Palm Beach	Pasco	Pinellas	Polk	Putnam	Sarasota	Seminole	St. Johns	St. Lucie	Sumter	Suwannee	Taylor	Union	Volusia	Walton	Washington	Total
Watermelons	396	1		25	2	328	34	5	2			537	1,086	10	10	45	1	124	9,960.2
Celery	66.3		5			2	50.5	902.3	6,440	28									8,749.8
Tomatoes	16.2	4.5	246.7	1.5		10.6		1.2	5.1		165	422.7			4.1	11.5			8,255.4
Green beans*	39.9	4.2	1,618.3	21		24.3	2.7	2.4	63.7	1.7	40	357			48.6	7.8			5,291.7
Early white potatoes	1	4	37.4	.6		2.1	575.3	3	.1	3,078.7	55.1				38	162.7			5,262.5
Cabbage	358.3	4	36	1		241	126.1	7	127.4	238.1	35	258				98.3			3,173.1
Cucumbers	191.5	4.5	1.9	4.3	.4	3.8	11.4	.4	1	23.6	.1	444.9			19.7	3.1			2,307.5
Peppers	26.3		129.6	3.2		29.3	.2	2.1	155.6	5.9	4.9	15.6			1.3	47.5			2,299.3
Strawberries	63.7			8.5	.7	311.4		5.6	.5			12.6			15.9				2,144.8
Lettuce	216							.7	321.8										935.9
Escarole	89							2	365.4							45.3			676.4
Eggplants			16.8	1.8		9.9			5.9		.1	1				.4			329.1
Romaine	49.3								83.7			2.4							292.6
Green corn	5		1			28.7				4.1		.1			1.8				292.5
Squashes		1.1	11.1	3.1		2.8	.6		3.4	.1	1.5	3.7			.4				236.5
Okra			6.8	3.1		.6	.5			.1	2.1	1.4							227.2
Green peas	.3	.1	28.2	.8		8.4		.2		1.1	1.3	4.8			.5				119
Cauliflower	1.2						7.5		1.6	15.1						.3			30
Avocados			.1																22.6
Cantaloupes												.7							17.8
Grapes				.5														4	17.3
Pineapples			5.1								4.1								11.4
Blueberries																			11
Carrots			2						.1	4.1									8.8
Chicory	6								1										7
Onions			1.3				.2			.1									5.3
Parsley									4.7										5.2
Beets									1.3										4.4
Turnips		.2																	2.4
Broccoli								.5	.2			.8							2.3
Mixed greens		.1				1.2			.7										2
Chinese cabbage		1.9																	1.9
Collards			1																1
Sorrel	1																		1
Spinach											.2								.2
Dasheens																			.1
Kale									.1										.1
Total	1,527	25.6	2,148.3	74.4	3.1	1,004.1	809	932.4	7,585.3	3,400.7	309.4	2,062.7	1,086	10	140.3	421.9	1	128	50,705.3

*Green beans includes lima beans.

TABLE LVIII.—SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF TRUCK CROPS BY COUNTIES, SEASON 1928-29.

Name of County	Equivalent Carloads	The Most Important Crops for the Counties
Seminole	7,585.3	Celery, 6,440; lettuce, 321.8: cabbage, 127.4; escarole, 365.4; peppers, 155.6.
Dade	4,738.1	Tomatoes, 3,817.6; cabbage, 205.5; peppers, 367.1; green beans, 178.8.
Manatee	3,537.7	Celery, 1209.6; lettuce, 225.7; escarole, 172; tomatoes, 1,138.8; cabbage, 194.2.
St Johns	3,400.7	Early white potatoes, 3,078.7; cabbage, 238.1.
Alachua	2,965.3	Watermelons, 1,421; cabbage. 290.3; cucumbers, 400.4; green beans, 280.9; early white potatoes, 260.2.
Marion	2,704.7	Watermelons, 850; tomatoes, 484.3; lettuce, 120.9; green beans, 538.3; cabbage, 401.2.
Broward	2,261.3	Green beans, 917.6; tomatoes, 540.9; peppers, 700.7.
Palm Beach	2,148.3	Green beans, 1,618.3; peppers, 129.6; tomatoes, 246.7.
Sumter	2,062.7	Watermelons, 537; tomatoes. 422.7; cucumbers, 444.9; green beans, 357; cabbage, 258.
Hillsborough	1,885.9	Strawberries, 1,010.6; tomatoes, 208.1; peppers, 268.9; green beans, 131.8.
Lake	1,789.4	Watermelons, 1,510; green beans, 43.6; cabbage, 162; cucumbers, 42.6.
Orange	1,527	Watermelons, 396; lettuce, 216; cabbage, 358.3; cucumbers, 191.5.
Gilchrist	1,250.4	Watermelons, 1,236; green corn, 12.1.
Levy	1,164.5	Watermelons, 646; okra, 38; cucumbers, 431.1; green beans, 36.4.
Hardee	1,089.9	Cucumbers, 425.2; tomatoes, 141.3; strawberries, 280.1; watermelons, 54.
Suwannee	1,086	Watermelons, 1,086.
Polk	1,004.1	Watermelons, 328; cabbage, 241; strawberries, 311.4; peppers, 29.3.
Sarasota	932.4	Celery, 902.3; cabbage, 7.
Putnam	809	Early white potatoes, 575.3; celery, 50.5; cabbage, 126.1; watermelons, 34.
Indian River	802.3	Tomatoes, 404.6; early white potatoes, 48.4; green beans, 271.5; peppers, 46.7.
Bradford	772.3	Strawberries, 399.7; green beans, 100.3; watermelons, 164; green corn, 81.4.
Jackson	714	Watermelons, 714.
Flagler	550 5	Early white potatoes, 396.4; cabbage, 154.
Volusia	421.9	Early white potatoes, 162.7; peppers, 47.5; watermelons, 45; cabbage 98.3; escarole, 45.3.
Lee	394.9	Peppers, 97.2; tomatoes, 86.3; watermelons, 43; eggplants, 93.3; early white potatoes, 30.4.
St. Lucie	309.4	Tomatoes 165; early white potatoes, 55.1; green beans, 40; cabbage, 35.
Martin	302.7	Green beans, 184.5; tomatoes, 73.8; peppers, 18.9.
Clay	286.9	Early white potatoes, 254; peppers 16.1; cabbage, 9.5.

TABLE LVIII.—SUMMARY OF EQUIVALENT CAR-LOT SHIPMENTS OF TRUCK CROPS BY COUNTIES, SEASON 1928-29—Continued.

Name of County	Equivalent Carloads	The Most Important Crops for the Counties
Collier	243.5	Tomatoes, 202.3; watermelons, 9; peppers, 19.1.
Hendry	235.9	Green beans, 112.3; tomatoes, 59.6; early white potatoes, 20; watermelons, 21.
Hamilton	232	Watermelons, 229; cucumbers, 3.
Okeechobee	199.7	Tomatoes, 104.7; early white potatoes, 11; green beans, 70.7; peppers, 6.6.
Holmes	170	Watermelons, 170.
Union	140.3	Green beans, 48.6; cucumbers, 19.7; early white potatoes, 38; strawberries, 15.9; watermelons, 10.
Glades	140	Cabbage, 63.1; green beans, 60.5; tomatoes, 4.2.
Washington	128	Watermelons, 124; grapes, 4.
Brevard	118.7	Peppers, 44; tomatoes, 17.9; celery, 32.
Columbia	105	Watermelons, 78; cucumbers, 27.
Pasco	74.4	Watermelons, 25; green beans, 21.
Escambia	51	Early white potatoes, 46; cabbage, 5.
Citrus	48.4	Watermelons, 45; eggplants, 1.4.
Hernando	45.9	Green beans, 12.6; tomatoes, 9.
DeSoto	44.1	Early white potatoes, 24; cabbage, 5; watermelons, 10.
Charlotte	43.1	Peppers, 15.8; early white potatoes, 6; tomatoes, 15.7.
Highlands	41.8	Watermelons, 26; early white potatoes, 6; celery, 8.
Lafayette	39	Watermelons, 39.
Monroe	31	Tomatoes, 30; green beans, 1.
Osceola	25.6	Tomatoes, 4.5; green beans, 4.2; cucumbers, 4.5.
Okaloosa	11	Blueberries, 11.
Taylor	10	Watermelons, 10.
Baker	9	Green corn, 9.
Madison	9	Watermelons, 9.
Duval	4.2	Early white potatoes, 3.6; cucumbers, .5.
Pinellas	3.1	Watermelons, 2.
Dixie	3	Watermelons, 3.
Walton	1	Watermelons, 1.
Total	50,705.3	

In Table LX is given a summary of the shipments of each crop each week and a total in the last column on the right showing the combined shipments per week from the state of all the crops studied.

Florida shipped more than 1,000 carloads of these commodities each week for 22 weeks from January 26 to June 22, inclusive. For 12 weeks the total shipments were between 100 and 1,000 equivalent carloads. Then for 18 weeks very few truck crops were shipped from the state. This slack period included the last half of July, all of August, September and October, and the first half of November.

The heaviest week was May 4, when a total of 3,185.2 equivalent carloads of all these commodities were shipped from the state.

The relative importance of crops as to the total number of cars shipped shows that watermelons ranked first with 9,960.2 equivalent carloads. The fractional car in this case was occasioned by a few going out by boat. Celery came next with 8,749.8 equivalent carloads; tomatoes 8,255.4; green beans 5,291.7; early white potatoes 5,262.5; cabbage 3,173.1; cucumbers 2,307.5; peppers 2,299.3; and strawberries 2,144.8 equivalent carloads. These are designated as the major truck crops of Florida. The other crops follow in order of importance based on amounts shipped and are shown thus in Table LX. Several of these crops shift position slightly from year to year, as the acreage of plantings and the yields per acre of the commodity vary.

APPENDIX

The total weekly shipments of each commodity from each freight, express and boat shipping point were tabulated on Form 1. The average car-lot loadings for one of the leading carriers for the season under study are shown in Table I. These were obtained by an actual count of the total packages of each truck crop shipped in 1928-29 by this carrier. In case a commodity was shipped in containers of different sizes it was converted to the most common size. The total number of equivalent packages of each crop was divided by the number of cars of each commodity shipped. Thus a representative average number of crates or hampers or other containers per car for that year was obtained.

TABLE I.—AVERAGE CAR-LOT LOADINGS FOR ONE OF THE LEADING CARRIERS FOR SEASON SEPT. 1, 1928 TO AUG. 31, 1929, INCLUSIVE.

Commodity	Unit	Total Units	Total Cars	Average Loading Per Car
Beans	⅞ bu. hamper	370,445	775	478
Cabbage	1½ bu. hamper	374,718	869	431
Celery	2 bu. crate	414,191	1,168	355
Corn, green	1 bu. hamper	43,578	86	507
Cucumbers	1 bu. crate	454,523	1,035	439
Eggplant	1 3/5 bu. crate	55,309	127	436
Escarole	1½ bu. hamper	53,687	124	433
Lettuce	1½ bu. hamper	110,043	261	422
Peppers	1 3/5 bu. crate	221,028	507	436
Potatoes	Bbls., 2¾ bu.	25,865	142	182
	Hampers	61,322	110	557
Romaine	1 bu. hamper	49,480	118	419
Strawberries	32 qt. crate	147,851	821	180
Tomatoes	40 lb. crate	908,537	2,051	443

Form 1

FLORIDA AGRICULTURAL EXPERIMENT STATION
Department of Agricultural Economics

Shipping Point... Commodity...

Carlot Shipments by Weeks, September, 1928, to August, 1929

September				October				November			
8	15	22	29	6	13	20	27	3	10	17	24

December					January				February			
1	8	15	22	29	5	12	19	26	2	9	16	23

March					April				May			
2	9	16	23	30	6	13	20	27	4	11	18	25

June					July				August				
1	8	15	22	29	6	13	20	27	3	10	17	24	31

Bulletin 245 April, 1932

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UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
Wilmon Newell, Director
(In Cooperation With the Division of Resident Teaching, College of Agriculture, University of Florida)

FARMERS' COOPERATIVE ASSOCIATIONS IN FLORIDA

I. Status and Legal Phases

By Marvin A. Brooker and H. G. Hamilton

Bulletins will be sent free upon application to the
Agricultural Experiment Station
GAINESVILLE, FLORIDA

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ORGANIZATION AND MANAGEMENT problems of the cooperative associations listed in this bulletin are being studied. The results of this study will be published later and will include an analysis of sales, contracts, volume, methods of financing and of control, and other factors.

FARMERS' COOPERATIVE ASSOCIATIONS IN FLORIDA

I. Status and Legal Phases

By MARVIN A. BROOKER and H. G. HAMILTON*

The study of farmers' cooperative associations in Florida was undertaken for the purpose of securing information relative to the development and present status of these associations, and for determining some of the factors which contribute to their success or failure. As an aid in this last phase of the study, attention has been given to inactive as well as active associations. This introductory study will present a classified list of the active and inactive associations which have been organized in Florida, with some supplementary information gained from their charters and by interviews, and a discussion of the principal Federal and State laws governing cooperative associations.

METHOD OF STUDY

The charters of incorporated cooperative associations which have organized in Florida were examined at the office of the Secretary of State. From these charters were obtained the addresses of the associations and of the charter applicants, dates of incorporation, purposes of organization, periods to exist, whether stock or non-stock, and similar information. An additional list of unincorporated cooperative associations was made up from a number of sources, including information from the State Marketing Bureau, the Packer Produce Red Book, County Agricultural Agents, and inquiries of agricultural leaders throughout the state. It is not claimed that the list includes all unincorporated associations which have been organized in this state, but it is believed that most of the principal ones have been included.

ACKNOWLEDGMENTS:—The Florida Citrus Exchange by means of its auditing system facilitated the study of the entire Citrus Exchange organization. Other associations cooperated as freely with the study of their own organizations. The office of the Secretary of State granted many courtesies in connection with the study of the charters of the incorporated associations. The writers wish to express their thanks to all the above and to Dr. C. V. Noble under whose direction this study was made.

*Associate Professor of Marketing, College of Agriculture, University of Florida.

Personal visits were then made to each of these associations and a detailed study made of its organization and method of operation. This extensive survey was the basis for the information given in the list as to whether the association was active or inactive during the season 1929-30.

CLASSIFICATION OF COOPERATIVE ASSOCIATIONS

The cooperative associations were classified in the list presented herewith on the basis of the principal products handled or services rendered in connection with these products. The largest group of associations was organized for handling citrus fruits. The group next in importance was organized for handling truck crops, with the one for handling livestock and livestock products ranking third. The fourth group is composed of subsidiary corporations, which are under the direct control of cooperative associations found in the other groups. Most of these subsidiary corporations were organized for discounting notes with the Intermediate Credit Bank in order to secure production credit for the members. A number of associations of various types, and those for which there was not sufficient information to classify them definitely in one of the other groups, were brought together in a miscellaneous group.

Cooperative associations are local or regional as to type. The local associations are further classified as to independent or federated. Independent locals are associations serving a distinct locality and doing business usually at one station. Federated locals differ from independent locals in that they are affiliated with other locals for the purpose of uniting their efforts in selling or engaging in other activities.

Regional associations are federated or centralized. Federated associations are central agencies formed of groups of locals for the purpose of performing certain specialized services. Centralized associations often perform similar services to the federated type, but the control of the business rests with the central rather than with the locals as in the case of the federated association, and the contract runs directly between the association and the grower rather than through a local association. In the case of the centralized association, the property rights are vested in the central organization, whereas in the federated type all local property is usually owned by the local organizations.

Organizations connected with the earlier national cooperative movements, such as the Grange, the Farmers' Alliance, and the Farmers' Union, are not included in this list.

CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA

CITRUS

NAME	Address Post Office	Address County	Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Perform or Activities Proposed
Altoona Citrus Growers' Association	Altoona	Lake	No	8-29-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Alturas Fruit Growers' Association Formerly the Alturas Citrus Growers' Association	Alturas	Polk	Yes	1-31-16	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Alva Citrus Growers' Association	Alva	Lee	No	8-3 -10	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Arcadia Citrus Growers' Association	Arcadia	DeSoto	Yes	10-30-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Astor Fruit and Vegetable Growers' Ass'n	Astor	Lake	No	2-29-16	Cooperative Act, 1909	Independent Local	Non-Stock	Citrus and vegetables
Auburndale Citrus Growers' Association	Auburndale	Polk	Yes	8-13-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Avon Park Citrus Growers' Association	Avon Park	Highlands	Yes	8-5 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Babson Park Citrus Growers' Association Formerly Lake Region Citrus Growers' Association and Crooked Lake Citrus Growers' Association	Babson Park	Polk	Yes	12-8 -09	Cooperative Act, 1909	Independent Local	Non-Stock	Citrus
Balm Citrus Growers' Association	Balm	Hillsborough	No	9-9 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Bartow Citrus Growers' Association	Bartow	Polk	Yes	8-20-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Bay County Satsuma Growers' Association	Panama City	Bay	Yes	1929	Not Incorporated	Independent Local	Non-Stock	Citrus
Bay View Citrus Growers' Association	Bay View	Pinellas	No	8-5 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Bowling Green Citrus Growers' Association	Bowling Green	Hardee	Yes	9-6 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Boynton Pineapple and Citrus Growers' Association	Boynton	Palm Beach	No	12-1 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus and pineapples
Bradenton Citrus Growers' Association	Bradenton	Manatee	Yes	9-9 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Brooksville Citrus Growers' Associaion	Brooksville	Hernando	Yes	8-6 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Broward Citrus Growers' Association	Ft. Lauderdale	Broward	*	8-29-31	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Candler Citrus Growers' Association	Candler	Marion	No	5-3 -15	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Center Hill Citrus Growers' Association	Center Hill	Sumter	No	10-6 -15	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Charlotte County Sub-Exchange Formerly Arcadia Citrus Sub-Exchange	Arcadia	DeSoto	Yes	10-11-09	Cooperative Act, 1909	Federated District	Non-Stock	**
Citra Citrus Growers' Association	Citra	Marion	No	5-3 -15	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Citrus City Growers' Association	Largo	Pinellas	Yes	5-8 -24	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
City Point Citrus Growers' Association	City Point	Brevard	No	9-6 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Clearwater Citrus Growers' Association	Clearwater	Pinellas	No	8-2 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Clermont Citrus Growers' Association	Clermont	Lake	Yes	9-18-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Cocoa Citrus Growers' Association	Cocoa	Brevard	No	10-15-14	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Cocoa-Merritts Island Citrus Association	Cocoa	Brevard	Yes	3-19-19	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Coconut Grove Citrus Growers' Association	Coconut Grove	Dade	No	11-15-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Cosme Citrus Growers' Association	Cosme	Hillsborough	No	10-13-24	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus

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*Organized too late to operate during the season of 1929-30.

**These Sub-Exchanges do not handle fruit, but were organized for purposes of representation on the board of directors of the central Exchange only. Ordinarily known as pa Sub-Exchanges.

CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA—Continued.

CITRUS

NAME	Address Post Office	County	Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Performe or Activities Proposed
Courtney Citrus Growers' Association	Courtney	Brevard	No	8-23-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Crescent City Citrus Growers' Association	Crescent City	Putnam	Yes	8-30-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Dade City Citrus Growers' Association	Dade City	Pasco	Yes	8-2 -20	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Dade County Citrus Sub-Exchange	Miami	Dade	Yes	1-26-10	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
Davenport Citrus Growers' Association	Davenport	Polk	No	12-11-15	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Davenport Fruit Growers' Association	Davenport	Polk	*	8-26-31	Agri. Coop. Act, 1931	Federated Local	Non-Stock	Citrus
Davie Fruit and Vegetable Growers' Ass'n	Davie	Broward	No	11-26-17	Cooperative Act, 1909	Independent Local	Non-Stock	Citrus and vegetables
DeLand Citrus Growers' Association	DeLand	Volusia	Yes	8-30-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
DeLand Packing House Association	DeLand	Volusia	Yes	11-7 -29	Coop. Mark. Act, 1923	Federated Local	Non-Stock	Citrus
Delray Pineapple and Citrus Growers' Ass'n	Delray	Palm Beach	No	1-26-10	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus and pineapples
DeSoto Citrus Growers' Association	Arcadia	DeSoto	No	6-4 -26	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
DeSoto Citrus Sub-Exchange	Arcadia	DeSoto	Yes	7-28-24	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
DeSoto City Growers' Association	DeSoto City	Highlands	No	5-28-25	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
DeSoto County Citrus Sub-Exchange Formerly North DeSoto Citrus Sub-Exchange	Wauchula	Hardee	No	2-26-10	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
Dundee Citrus Growers' Association	Dundee	Polk	Yes	4-24-24	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Eagle Lake Fruit Growers' Association Formerly Eagle Lake Citrus Growers' Association	Eagle Lake	Polk	Yes	9-6 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
East Hillsborough Citrus Growers' Ass'n	Plant City	Hillsborough	Yes	10-14-29	Coop. Mark. Act, 1923	Federated Local	Non-Stock	Citrus
Eldred Pineapple and Citrus Growers' Ass'n	Eldred	St. Lucie	No	11-15-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Elfers Citrus Growers' Association	Elfers	Pasco	Yes	4-10-20	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Emporia Citrus Growers' Association	Emporia	Volusia	No	10-1 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Emeralda Citrus Growers' Association	Emeralda	Lake	No	8-10-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Escambia County Citrus Growers' Ass'n	Pensacola	Escambia	Yes	1926	Not Incorporated	Federated Local	Non-Stock	Citrus
Escambia County Satsuma Orange Growers' Cooperative Association	Ensley	Escambia	*	8-27-31	Agri. Coop. Act, 1931		Non-Stock	Citrus
Eustis Citrus Growers' Association	Eustis	Lake	No	9-3 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Fellsmere Citrus Growers' Association	Fellsmere	Indian River	No	7-7 -19	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Florence Citrus Growers' Association	Florence Villa	Polk	Yes	7-31-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Florence Villa Citrus Sub-Exchange	Florence Villa	Polk	Yes	4-9 -24	Cooperative Act, 1909	Federated District	Non-Stock	**
Florida Citrus Exchange	Tampa	Hillsborough	Yes	7-20-09	Cooperative Act, 1909	Federated	Non-Stock	Citrus
Florida Citrus Growers' Clearing House Association	Winter Haven	Polk	Yes	4-13-28	Coop. Mark. Act, 1923		Non-Stock	Citrus
Florida Fruit and Vegetable Growers' Ass'n	Jacksonville	Duval	No	5-2 -1894	Gen. Corporation Law	Centralized	Stock	Citrus and vegetables

*Organized too late to operate during the season of 1929-30.

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CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA—Continued.

CITRUS

NAME	Address		Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Performe or Activities Proposed
	Post Office	County						
Fort Lauderdale Citrus Growers' Association	Ft. Lauderdale	Broward	No	6-2 -20	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Fort Meade Citrus Growers' Association	Fort Meade	Polk	No	9-18-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Fort Meade Fruit Growers' Association	Fort Meade	Polk	*	10-9 -30	Coop. Mark. Act, 1923	Federated Local	Non-Stock	Citrus
Fort Myers Cooperative Citrus Growers Formerly Fort Myers Citrus Growers' Association	Fort Myers	Lee	Yes	11-1 -12	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Fort Ogden Citrus Growers' Association	Fort Ogden	DeSoto	Yes	8-7 -11	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Fort Pierce Fruit Association	Fort Pierce	St. Lucie	No	11-15-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Fort Pierce Growers' Association	Fort Pierce	St. Lucie	Yes	12-10-17	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Fort Pierce Pineapple and Citrus Sub-Exchange	Fort Pierce	St. Lucie	No	12-8 -09	Cooperative Act, 1909	Federated District	Non-Stock	**
Frostproof Citrus Growers' Association	Frostproof	Polk	Yes	9-9 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Gardner Citrus Growers' Association	Gardner	Hardee	No	9-3 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Groveland Citrus Growers' Association	Groveland	Lake	Yes	4-14-20	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Groveland Fruit Growers' Association	Groveland	Lake	*	7-18-31	Cooperative Act, 1909		Non-Stock	Citrus
Geneva Citrus Growers' Association	Geneva	Seminole	No	7-28-13	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Gulf Citrus Growers' Association	Clearwater	Pinellas	No	8-28-16	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Haines City Citrus Growers' Association	Haines City	Polk	Yes	8-13-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Hillsborough Citrus Sub-Exchange	Tampa	Hillsborough	Yes	7-22-10	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
Homeland Citrus Growers' Association	Homeland	Polk	Yes	8-30-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Howey Citrus Growers' Association	Howey	Lake	No	11-14-24	Cooperative Act, 1909	Independent Local	Non-Stock	Citrus
Indian River Citrus Growers' Association	Fort Pierce	St. Lucie	*	4-1 -31	Coop. Mark. Act, 1923		Non-Stock	Citrus
Indian River Citrus Growers' Association	Mims	Brevard	No	9-3 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Indian River Citrus Sub-Exchange	Cocoa	Brevard	Yes	10-9 -09	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
Indian River Growers, Incorporated	Vero Beach	Indian River	*	4-15-31	Coop. Mark. Act, 1923	Federated Local	Non-Stock	Citrus
Indian River Orange Growers' Association	City Point	Brevard	No	1-4-1889	Gen. Corporation Law	Independent Local	Stock	Citrus
Interlachen Citrus Growers' Association	Interlachen	Putnam	No	5-25-28	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Island Citrus Sub-Exchange	Ft. Myers	Lee	No	10-18-18	Cooperative Act, 1909	Federated District	Non-Stock	**
Jensen Pineapple and Citrus Growers' Association	Jensen	Martin	No	12-1 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Keystone Park Citrus Growers' Association	Keystone Park	Hillsborough	No	9-28-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Keysville Citrus Growers' Association	Keysville	Hillsborough	No	9-9 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Kissimmee Citrus Growers' Association	Kissimmee	Osceola	Yes	10-24-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lake Alfred Citrus Growers' Association	Lake Alfred	Polk	Yes	4-19-19	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus

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CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA—Continued.

CITRUS

NAME	Address Post Office	Address County	Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Performe or Activities Proposed
Lake Apopka Citrus Sub-Exchange	Orlando	Orange	Yes	5-19-24	Cooperative Act, 1909	Federated District	Non-Stock	**
Lake Ariana Citrus Growers' Association	Auburndale	Polk	No	4-28-24	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lake Carroll Citrus Growers' Association	Tampa	Hillsborough	*	7-25-30	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lake Como Citrus Growers' Association	Lake Como	Putnam	No	11-15-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lake County Orange Growers' Association	Leesburg	Lake	No	6-24-15	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lake County Sub-Exchange, Formerly Highlands Citrus Sub-Exchange	Leesburg	Lake	Yes	9-6 -09	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
Lake Garfield Citrus Growers' Association	Bartow	Polk	Yes	4-1 -14	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lake Hamilton Citrus Growers' Association	Lake Hamilton	Polk	Yes	8-1 -18	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lake Helen Citrus Growers' Association	Lake Helen	Volusia	No	10-30-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lake Howard Citrus Growers' Association	Winter Haven	Polk	No	6-2 -24	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lake Jem Citrus Growers' Association	Lake Jem	Lake	No	7-7 -12	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lake Jovita Citrus Growers' Association	San Antonio	Pasco	*	7-2 -31	Cooperative Act, 1909		Non-Stock	Citrus
Lakeland Citrus Growers' Association	Lakeland	Polk	Yes	7-31-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lakeland-Highlands Citrus Growers' Ass'n	Highlands City	Polk	Yes	6-16-21	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lake Placid Citrus Growers' Association	Lake Placid	Highlands	*	4-7 -30	Coop. Mark. Act, 1923	Federated Local	Non-Stock	Citrus
Lake Region Citrus Sub-Exchange	Haines City	Polk	Yes	4-9 -24	Cooperative Act, 1909	Federated District	Non-Stock	**
Lake Region Packing Association	Tavares	Lake	Yes	8-10-10	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lake Wales Citrus Growers' Association	Lake Wales	Polk	Yes	7-31-18 8-17-31	Cooperative Act, 1909 Agri. Coop. Act, 1931	Federated Local	Stock	Citrus
Lake Weir Citrus Growers' Association	East Lake	Marion	Yes	5-3 -15	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Largo Citrus Growers' Association	Largo	Pinellas	No	7-31-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Leeco Citrus Growers' Association	Ft. Myers	Lee	No	7-27-20	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lee County Sub-Exchange	Ft. Myers	Lee	No	11-1 -12	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
Leesburg Citrus Growers' Association	Leesburg	Lake	Yes	8-27-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Leesburg Orange Growers' Association	Leesburg	Lake	No	5-28-15	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Leesburg Sub-Exchange	Leesburg	Lake	No	9-6 -09	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
Lilly Citrus Growers' Association	Limestone	Hardee	No	8-13-23	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Limona Citrus Growers' Association	Limona	Hillsborough	No	8-30-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Lutz Citrus Growers' Association	Lutz	Hillsborough	No	11-24-16	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
McIntosh Citrus Growers' Association	McIntosh	Marion	Yes	5-3 -15	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Maitland Citrus Growers' Association	Maitland	Orange	No	8-13-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus

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CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA—Continued.

CITRUS

NAME	Address		Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Performed or Activities Proposed
	Post Office	County						
Mammoth Grove Owners' Association	Mam'th Groves	Polk	No	2-19-25	Cooperative Act, 1909	Independent Local	Non-Stock	Citrus
Manatee Citrus Growers' Association	Manatee	Manatee	Yes	9-18-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Manatee County Citrus Sub-Exchange	Bradenton	Manatee	Yes	9-28-09	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
Marion County Citrus Sub-Exchange	Ocala	Marion	Yes	5-3 -15	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
Miakka Citrus Growers' Association	Miakka	Sarasota	No	10-1 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Miami Citrus Growers' Association	Miami	Dade	No	10-1 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Micco Citrus Growers' Association	Micco	Brevard	No	11-8- 24	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Mims Citrus Growers' Association	Mims	Brevard	Yes	3-26-28	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Moss Bluff Citrus Growers' Association	Moss Bluff	Marion	Yes	8-28-26	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Mt. Dora Citrus Growers' Association	Mt. Dora	Lake	Yes	9-6 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Naranja Citrus Growers' Association	Naranja	Dade	No	11-15-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
New Pomona Citrus Growers' Association	Pomona	Putnam	Yes	9-29-24	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Nocatee Citrus Growers' Association	Nocatee	DeSoto	Yes	10-13-15	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
North DeLand Citrus Growers' Association	DeLand	Volusia	No	7-23-14	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Oak Hill Citrus Growers' Association Formerly Smyrna and Hawks Park Citrus Growers' Association	Oak Hill	Volusia	Yes	10-1 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Ocala Citrus Association	Ocala	Marion	Yes	9-2 -15	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Ocoee Citrus Growers' Association	Ocoee	Orange	No	8-27-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Okahumpka Citrus Growers' Association	Okahumpka	Lake	*	3-18-30	Coop. Mark. Act, 1923	Federated Local	Non-Stock	Citrus
Okeechobee Citrus Growers' Association	Okeechobee	Okeechobee	No	5-7 -24	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Ona Citrus Growers' Association	Ona	Hardee	No	8-13-23	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Oneco Citrus Growers' Association	Oneco	Manatee	No	9-25-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Orange City Citrus Growers' Association	Orange City	Volusia	No	11-20-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Orange County Citrus Sub-Exchange	Orlando	Orange	Yes	7-19-20	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
Orlando Citrus Growers' Association	Orlando	Orange	Yes	8-4 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Oslo Pineapple and Citrus Growers' Association	Oslo	Indian River	No	10-9 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Oveido Citrus Growers' Association	Oviedo	Seminole	No	1921	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Owanita Citrus Growers' Association	Owanita	Lee	Yes	8-27-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Ozona Citrus Growers' Association	Ozona	Pinellas	No	8-16-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Palma Sola Citrus Growers' Association	Palma Sola	Manatee	No	10-6 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Palmetto-Indian River Citrus Growers' Association	White City	St. Lucie	No	10-1 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus

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CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA—Continued.

CITRUS

NAME	Address		Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Performed, or Activities Proposed
	Post Office	County						
Palm Harbor Citrus Growers' Association	Palm Harbor	Pinellas	Yes	4-30-24	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Parrish Citrus Growers' Association	Parrish	Manatee	No	9-29-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Pierson Citrus Growers' Association	Pierson	Volusia	Yes	9-18-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Pinellas Citrus Sub-Exchange	Clearwater	Pinellas	Yes	9-6 -09	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
Plant City Citrus Growers' Association	Plant City	Hillsborough	No	9-6 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Plymouth Citrus Growers' Association	Plymouth	Orange	Yes	10-6 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Polk County Citrus Sub-Exchange	Bartow	Polk	Yes	8-27-09	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
Pomona Citrus Growers' Association	Pomona	Putnam	No	9-25-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Punta Gorda Citrus Growers' Association	Punta Gorda	Charlotte	No	8-20-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Redlands Citrus Growers' Association	Homestead	Dade	Yes	2-17-19	Cooperative Act, 1909	Independent Local	Non-Stock	Citrus
Ridge Citrus Sub-Exchange	Lake Wales	Polk	Yes	4-9 -24	Cooperative Act, 1909	Federated District	Non-Stock	**
Ridge Pineapple and Citrus Growers' Association	Ft. Pierce	St. Lucie	No	9-28-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus and pineapples
River Valley Citrus Growers' Association Formerly Palmetto Citrus Growers' Association	Palmetto	Manatee	Yes	May, 1924	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Round Lake Satsuma Packing House Co.	Round Lake	Jackson	Yes	10-14-29	Coop. Mark. Act, 1923	Federated Local	Non-Stock	Citrus
Safety Harbor Citrus Growers' Association	Safety Harbor	Pinellas	No	9-6 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
St. Johns River Sub-Exchange	DeLand	Volusia	Yes	10-30-09	Cooperative Act, 1909	Federated District	Non-Stock	Citrus
St. Petersburg Citrus Growers' Association	St. Petersburg	Pinellas	No	7-31-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
San Antonio Citrus Growers' Association	San Antonio	Pasco	No	11-20-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
San Mateo Citrus Growers' Association	San Mateo	Putnam	No	8-8 -23	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Sarasota Citrus Growers' Association	Sarasota	Sarasota	Yes	9-6 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Scenic Citrus Sub-Exchange	Avon Park	Highlands	Yes	4-9 -24	Cooperative Act, 1909	Federated District	Non-Stock	**
Sebring Fruit Growers' Association Formerly Sebring Citrus Growers' Association	Sebring	Highlands	Yes	1-31-17	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Seffner Citrus Growers' Association	Seffner	Hillsborough	No	8-27-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Seminole Orange Sub-Exchange	Orlando	Orange	Yes	5-19-27	Cooperative Act, 1909	Federated District	Non-Stock	**
Seville Citrus Growers' Association	Seville	Volusia	No	4-29-22	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Silver Palm Citrus Growers' Association	Naranja	Dade	Yes	9-1 -21	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Sorrento Citrus Growers' Association	Sorrento	Lake	No	8-30-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Southern Citrus Growers' Association	Lakeland	Polk	No	8-27-24	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus

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CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA—Continued.

CITRUS

NAME	Address		Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Perform or Activities Proposed
	Post Office	County						
South Lake Apopka Citrus Growers' Ass'n	Oakland	Orange	Yes	8-25-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Stuart Citrus Growers' Association	Stuart	Martin	No	8-11-24	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Stuart Pine and Citrus Growers' Ass'n	Stuart	Martin	No	10-30-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus and pineapples
Sugar Belt Citrus Growers' Association	Narcoossee	Osceola	No	5-1 -24	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Tampa Citrus Growers' Association	Tampa	Hillsborough	Yes	8-16-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Tangerine Citrus Growers' Association	Tangerine	Orange	No	9-18-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Tavares Citrus Growers' Association	Tavares	Lake	No	9-24-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Terra Ceia Citrus Growers' Association	Terra Ceia	Manatee	Yes	5-3 -12	Cooperative Act, 1909	Independent Local	Non-Stock	Citrus
Thonotosassa Citrus Growers' Association	Thonotosassa	Hillsborough	No	9-9 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Titusville-Indian River Citrus Growers' Association	Titusville	Brevard	No	9-9 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Trilby Citrus Growers' Association	Trilby	Pasco	No	10-12-12	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Tropical Citrus Growers' Association	Ft. Myers	Lee	No	5-18-14	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Umatilla Citrus Growers' Association	Umatilla	Lake	Yes	8-13-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Valrico Citrus Growers' Association	Valrico	Hillsborough	No	3-15-20	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Vero Citrus Growers' Association	Vero	Indian River	No	11-16-14	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Vero-Indian River Producers' Association	Vero Beach	Indian River	Yes	4-6 -21	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Viking Pineapple and Citrus Growers' Association	Viking	St. Lucie	No	10-6 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Walton Fruit Growers' Association	Walton	St. Lucie	No	12-8 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Wauchula Citrus Growers' Association	Wauchula	Hardee	No	8-7 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Waverly Citrus Growers' Association	Waverly	Polk	Yes	10-29-14	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
West DeLand Citrus Growers' Association	DeLand	Volusia	No	7-23-14	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
West Orange Citrus Growers' Association	Winter Garden	Orange	*	5-7 -31	Coop. Mark. Act, 1923		Non-Stock	Citrus
White City Citrus and Pineapple Growers' Association	White City	St. Lucie	No	1916	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Windermere Citrus Growers' Association	Windermere	Orange	No	11-8 -20	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Winter Garden Citrus Growers' Association	Winter Garden	Orange	Yes	8-23-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Winter Haven Citrus Growers' Association	Winter Haven	Polk	Yes	8-9 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Winter Haven Citrus Sub-Exchange	Winter Haven	Polk	Yes	4-9 -24	Cooperative Act, 1909	Federated District	Non-Stock	**
Winter Park Citrus Growers' Association	Winter Park	Orange	Yes	1909	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus
Zolfo Citrus Growers, Incorporated	Zolfo Springs	Hardee	*	4-4 -31	Coop. Mark. Act, 1923	Federated Local	Non-Stock	Citrus
Zolfo Springs Citrus Growers' Association Formerly Zolfo Citrus Growers' Association	Zolfo Springs	Hardee	No	9-18-09	Cooperative Act, 1909	Federated Local	Non-Stock	Citrus

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CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA—Continued.

TRUCK CROPS

NAME	Address		Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Performe or Activities Proposed
	Post Office	County						
Alachua County Cooperative Association	Gainesville	Alachua	Yes	12-15-23	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Cucumbers
Alachua Farmers' Cooperative Marketing and Purchasing Association	Gainesville	Alachua	No	1-17-24	Coop. Mark. Act, 1923	Independent Local	Stock	Cucumbers and beans
Archer Truckers' Association	Archer	Alachua	Yes	1924	Not Incorporated	Independent Local	Non-Stock	Cucumbers
Auburndale Strawberry Growers' Ass'n	Auburndale	Polk	No	1-25-28	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Strawberries
Barrineau Park Farmers' Society	Cantonment	Escambia	Yes	1914	Cooperative Act, 1909	Independent Local	Non-Stock	Potatoes and sweet potatoe
Barrineau Park Orange and Potato Growers' Association	Cantonment	Escambia	Yes	7-15-23	Cooperative Act, 1909	Independent Local	Non-Stock	Potatoes, S. potatoes, cabba
Bartow Vegetable Growers' Association	Bartow	Polk	No	7-21-17	Cooperative Act, 1909	Independent Local	Non-Stock	Truck Crops
Bowling Green Melon Growers' Association	Bowling Green	Hardee	No	7-16-19	Cooperative Act, 1909	Independent Local	Non-Stock	Watermelons
Bowling Green Produce Growers' Cooperative Association	Bowling Green	Hardee	Yes	Sept., 1929	Not Incorporated	Independent Local	Non-Stock	Strawberries and cabbage
Boynton Growers' and Shippers' Ass'n	Boynton	Palm Beach	No	2-5 -16	Cooperative Act, 1909	Independent Local	Non-Stock	Truck crops
Bradford County Strawberry and Vegetable Growers' Association	Starke	Bradford	Yes	11-6 -30	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Strawberries
Buck Pond Truck Growers' Association	Romeo	Citrus	No	1921	Not Incorporated	Independent Local	Non-Stock	Cucumbers, seed, fertilizer
Bunnell Potato Growers' Association	Bunnell	Flagler	No	9-6 -23	Cooperative Act, 1909	Independent Local	Non-Stock	Potatoes, seed, fertilizers
Calhoun County Strawberry Growers' Cooperative Association	Blountstown	Calhoun	*	8-2 -30	Coop. Mark. Act, 1923		Non-Stock	Truck crops
Center Hill Truck Growers' Association	Center Hill	Sumter	No	1915	Not Incorporated	Independent Local	Non-Stock	Truck crops
Charlotte County Growers' Association	Punta Gorda	Charlotte	Yes	11-4 -29	Coop. Mark. Act, 1923	Independent Local	Stock	Potatoes and peppers
Dade County Farmers' Cooperative Ass'n	Goulds	Dade	Yes	8-19-29	Coop. Mark. Act, 1923	Independent Local	Stock	Tomatoes
Dade County Strawberry Association	Miami	Dade	No	9-27-28	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Strawberries
DeSoto County Cooperative Association	Arcadia	DeSoto	Yes	8-19-29	Coop. Mark. Act, 1923	Independent Local	Stock	Cucumbers, watermelons,
DeSoto County Potato Growers' Association	Nocatee	DeSoto	Yes	1930	Not Incorporated	Independent Local	Non-Stock	Sweet potatoes
East Beach Growers' Association	Pahokee	Palm Beach	No	1-9 -18	Cooperative Act, 1909	Federated Local	Non-Stock	Truck crops
Escambia County Growers' Association	Ensley	Escambia	*	3-11-31	Coop. Mark. Act, 1923		Non-Stock	Truck crops
Everglades Growers' Association	Moore Haven	Glades	No	8-16-18	Cooperative Act, 1909	Federated Local	Non-Stock	Tomatoes
Everglades Vegetable Growers' Association	Zona	Dade	No	1-4 -13	Cooperative Act, 1909	Independent Local	Non-Stock	Truck crops
Farmers' Cooperative Marketing Association of Palm Beach County.	W. Palm Beach	Palm Beach	No	7-1 -21	Cooperative Act, 1909	Independent Local	Non-Stock	Tomatoes and potatoes
Fellsmere Truckers' Association	Fellsmere	Indian River	No	5-17-28	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Truck crops
Flagler Potato Growers' Association	Bunnell	Flagler	No	11-17-22	Cooperative Act, 1909	Independent Local	Non-Stock	Potatoes, seed, fertilizers
Florida City Growers' Association	Florida City	Dade	No	8-30-19	Cooperative Act, 1909	Independent Local	Non-Stock	Tomatoes
Florida East Coast Growers' Association	Miami	Dade	Yes	2-6 -18	Cooperative Act, 1909	Cent. and Federated	Non-Stock	Tomatoes
Florida Potato Growers' Association	Hastings	St. Johns	No	9-16-18	Cooperative Act, 1909	Independent Local	Non-Stock	Potatoes, seed, fertilizers
Florida State Celery Association	Sanford	Seminole	No	4-30-29	Cooperative Act, 1909	Centralized	Non-Stock	Celery
Florida Truck Growers, Incorporated	Bradenton	Manatee	*	10-3 -30	Corporation Law, 1925	Federated	Stock	Truck crops

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TRUCK CROPS

NAME	Address		Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Perform or Activities Proposed
	Post Office	County						
Florida Vegetable Corporation	Sanford	Seminole	Yes	6-30-23	Coop. Mark. Act, 1923	Independent Local	Stock	Celery
Florida Vegetable Growers' Association	Sanford	Seminole	No	5-11-10	Cooperative Act, 1909	Independent Local	Non-Stock	Truck crops
Fort Lauderdale Farmers' Association	Ft. Lauderdale	Broward	Yes	1-22-30	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Supplies
Fort Meade Vegetable Growers' Association	Fort Meade	Polk	Yes	March, 1930	Not Incorporated	Independent Local	Non-Stock	Sweet corn and potatoes
Fort Myers Truckers' Association	Fort Myers	Lee	No	12-20-18	Gen. Corporation Law	Independent Local	Stock	Truck crops
Fort Pierce Farmers' Association	Fort Pierce	St. Lucie	No	4-10-15	Cooperative Act, 1909	Independent Local	Non-Stock	Vegetables, tomatoes
Gadsden County Truck Growers' Ass'n	Quincy	Gadsden	*	9-23-30	Coop. Mark. Act, 1923		Non-Stock	Truck crops
Gainesville Farmers' Association	Gainesville	Alachua	Yes	10-20-24	Cooperative Act, 1909	Independent Local	Non-Stock	Cucumbers and beans
Galloway Shippers' Association	Galloway	Polk	Yes	1912	Not Incorporated	Independent Local	Stock	Strawberries packed
Glade Tomato Growers' Association	Goulds	Dade	Yes	12-29-26	Cooperative Act, 1909	Federated Local	Non-Stock	Tomatoes
Goulds Fruit and Vegetable Growers' Ass'n	Goulds	Dade	Yes	1-18-18	Cooperative Act, 1909	Federated Local	Non-Stock	Tomatoes
Green Cove Springs Vegetable Growers' Association	Green Cove Sp's	Clay	No	Feb., 1922	Cooperative Act, 1909	Independent Local	Non-Stock	Potatoes, strawb's, cucumb
Hardee County Growers' Association, Incorporated, Formerly Wauchula Truck Growers' Association	Wauchula	Hardee	Yes	7-17-15	Gen. Corporation Law	Independent Local	Stock	Strawberries and tomatoes
Hastings Potato Growers' Association	Hastings	St. Johns	Yes	July, 1922	Cooperative Act, 1909	Independent Local	Non-Stock	Potatoes
Haynesworth Farmers' Cooperative Ass'n	Haynesworth	Alachua	Yes	3-16-26	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Cucumbers and beans
Hernando County Growers' Association	Brooksville	Hernando	Yes	1929	Not Incorporated	Independent Local	Non-Stock	Beans and eggplants
Hillsborough County Cooperative Marketing Association	Tampa	Hillsborough	*	3-9 -31	Coop. Mark. Act, 1923		Non-Stock	Truck crops
Homestead Growers' Association	Homestead	Dade	Yes	5-24-19	Cooperative Act, 1909	Federated Local	Non-Stock	Tomatoes
Homestead Sub-Exchange	Homestead	Dade	Yes	11-29-26	Cooperative Act, 1909	Federated	Non-Stock	Tomatoes
LaCrosse Potato Growers' Association	LaCrosse	Alachua	Yes	1923	Cooperative Act, 1909	Independent Local	Non-Stock	Potatoes
Lakeland Strawberry Association	Lakeland	Polk	Yes	2-13-31	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Strawberries
Leesburg Truckers' Association	Leesburg	Lake	Yes	1913	Not Incorporated	Independent Local	Non-Stock	Cabbage
Long Branch Growers' Association	Long Branch	Clay	No	4-14-22	Cooperative Act, 1909	Independent Local	Non-Stock	Vegetables
Manatee County Growers' Association	Bradenton	Manatee	Yes	2-4 -24	Coop. Mark. Act, 1923	Centralized	Stock	Celery, tomatoes, peppers
Marion Farmers' Cooperative Association	Ocala	Marion	No	3-16-26	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Tomatoes and cucumbers
Martin County Growers' Association	Stuart	Martin	Yes	11-9 -27	Coop. Mark. Act, 1923	Independent Local	Stock	Potatoes, peppers, eggplant
Mount Carmel Produce Company	Jay	Santa Rosa	Yes	12-23-24	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Beans, cucumbers, tomatoes
Melbourne Farms Cooperative Association	Melbourne	Brevard	No	1-28-27	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Truck crops
Naranja Truckers' Association	Naranja	Dade	No	11-3 -23	Cooperative Act, 1909	Independent Local	Non-Stock	Truck crops
Nassau County Dasheen Growers' Ass'n	Callahan	Nassau	Yes	10-19-23	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Dasheens

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TRUCK CROPS

NAME	Address Post Office	County	Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Performe or Activities Proposed
Nocatee Vegetable Growers' Association	Nocatee	DeSoto	Yes	9-13-27	Coop. Mark. Act, 1923	Independent Local	Stock	Cucumbers and watermelons
Okeechobee County Growers' Association	Okeechobee	Okeechobee	No	9-30-27	Coop. Mark. Act, 1923	Independent Local	Stock	Vegetables
Palm Beach County Everglades Cooperative Association	Belle Glade	Palm Beach	No	1-3 -28	Coop. Mark. Act, 1923	Independent Local	Stock	Truck crops
Palm Beach County Growers' Association	W. Palm Beach	Palm Beach	Yes	2-15-29	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Beans, tomatoes, peppers
Palm Beach Farmers' Cooperative Ass'n	Delray Beach	Palm Beach	Yes	5-8 -24	Coop. Mark. Act, 1923	Independent Local	Stock	Peppers, beans, tomatoes
Palmer Farms Growers' Cooperative Ass'n	Sarasota	Sarasota	Yes	8-7 -28	Coop. Mark. Act, 1923	Independent Local	Stock	Celery
Palmetto Buyers' Cash Platform	Palmetto	Manatee	Yes	1928	Not Incorporated	Independent Local	Non-Stock	Beans, peppers, squash
Pelican Point Growers' Association	Pahokee	Palm Beach	No	1-9 -18	Cooperative Act, 1909	Federated Local	Non-Stock	Truck crops
Perrine Truckers' Association	Perrine	Dade	No	11-10-23	Cooperative Act, 1909	Federated Local	Non-Stock	Truck crops
Pinellas County Farmers' Cooperative Ass'n	Clearwater	Pinellas	Yes	12-13-29	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Cucumbers, cabbage, potato
Plant City Cooperative Association	Plant City	Hillsborough	*	1-3 -31	Coop. Mark. Act, 1923		Non-Stock	Truck crops
Polk County Farmers' Association, Incorporated, Formerly Polk County Farm Labor Union Association	Kathleen	Polk	Yes	10-19-25	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Strawberries, beans, pepper
Polk County Vegetable Growers' Ass'n	Winter Haven	Polk	No	5-17-27	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Potatoes
Princeton Growers' Association	Princeton	Dade	Yes	2-18-25	Cooperative Act, 1909	Federated Local	Non-Stock	Tomatoes
Reddick Farmers' Cooperative Association	Reddick	Marion	No	4-13-26	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Tomatoes and melons
Royal Palm Truckers' Association	Homestead	Dade	Yes	9-6 -20	Cooperative Act, 1909	Federated Local	Non-Stock	Tomatoes
St. Cloud Growers' Association	St. Cloud	Osceola	Yes	1928	Not Incorporated	Independent Local	Non-Stock	Potatoes and beans
St. Johns Cooperative Association	Hastings	St. Johns	Yes	10-8 -29	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Potatoes
Samsula Cooperative Truckers' Association	Samsula	Volusia	*	12-30-30	Coop. Mark. Act, 1923		Non-Stock	Truck crops
Samsula Farmers' and Truckers' Ass'n	Samsula	Volusia	Yes	10-28-27	Cooperative Act, 1909	Independent Local	Non-Stock	Peppers and escarole
San Antonio Strawberry Growers' Ass'n	San Antonio	Pasco	No	9-2-1899	Not Incorporated	Independent Local	Non-Stock	Strawberries
Sanford Farmers' Exchange	Sanford	Seminole	Yes	9-13-18	Cooperative Act, 1909	Federated Local	Non-Stock	Celery
Sanford-Oviedo Truck Growers, Inc.	Sanford	Seminole	Yes	1919	Gen. Corporation Law	Independent Local	Stock	Celery and escarole
Santa Fe Truck Growers' Association	Santa Fe	Alachua	No	10-12-23	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Cucumbers
Seven Star Vegetable Growers, Formerly Lee County Cooperative Association	Fort Myers	Lee	Yes	1-18-27	Coop. Mark. Act, 1923	Independent Local	Stock	Peppers, tomatoes, eggplan
South Florida Strawberry and Vegetable Growers' Association	Groveland	Lake	No	8-28-16	Cooperative Act, 1909	Independent Local	Non-Stock	Truck crops
South Indian River Growers' Association	Jupiter	Palm Beach	*	April, 1930	Not Incorporated	Independent Local	Non-Stock	Tomatoes, peppers, potatoe
South Side Farmers' Cooperative Ass'n	McIntosh	Marion	Yes	4-6 -26	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Cabbage and lettuce
Standard Growers' Association	Sanford	Seminole	*	11-15-30	Coop. Mark. Act, 1923		Non-Stock	Truck crops
Starke Growers' Association	Starke	Bradford	No	7-12-21	Cooperative Act, 1909	Independent Local	Non-Stock	Strawberries, fertilizers, se

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CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA—Continued.

TRUCK CROPS

NAME	Address		Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Perform or Activities Proposed
	Post Office	County						
Sumter County Farmers' Cooperative Ass'n	Webster	Sumter	*	1-9 -30	Not Incorporated	Independent Local	Non-Stock	Truck crops
Sumter County Farmers' Cooperative Marketing and Purchasing Association	Webster	Sumter	No	5-13-24	Coop. Mark. Act, 1923	Independent Local	Stock	Cucumbers and tomatoes
Sumter County Florida Strawberry Corporation, Incorporated	Webster	Sumter	*	9-3 -30	Coop. Mark. Act, 1923		Stock	Strawberries
Sumter County Growers' Association	Bushnell	Sumter	Yes	1927	Coop. Mark. Act, 1923	Independent Local	Stock	Cucumbers and tomatoes
Suwannee County Cooperative Marketing and Purchasing Association	Live Oak	Suwannee	No	1-29-24	Coop. Mark. Act, 1923	Independent Local	Stock	Watermelons
Sydney Truck Growers' Union	Sydney	Hillsborough	No	1915	Not Incorporated	Independent Local	Non-Stock	Strawberries
Triangle Growers' Association, Formerly Prosperity Growers' Association	Prosperity	Palm Beach	No	1-16-18	Cooperative Act, 1909	Independent Local	Non-Stock	Truck crops
Truck and Fruit Growers, Incorporated	Barrineau Park	Escambia	No	5-28-26	Coop. Mark. Act, 1923	Independent Local	Stock	Truck crops
Turkey Creek Growers' Association	Turkey Creek	Hillsborough	No	1925	Not Incorporated	Independent Local	Non-Stock	Strawberries
Union Truck Growers' Association	Samsula	Volusia	Yes	8-19-29	Cooperative Act, 1909	Independent Local	Non-Stock	Escarole and peppers
United Growers' Association, Incorporated	Kathleen	Polk	Yes	Dec., 1929	Not Incorporated	Independent Local	Stock	Strawb's, peppers, broccoli
Volusia County Potato Growers' Ass'n	Samsula	Volusia	Yes	11-26-23	Cooperative Act, 1909	Independent Local	Non-Stock	Potatoes
Volusia Vegetable Growers' Association	Samsula	Volusia	Yes	11-26-27	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Peppers, escarole, cabbage
Waldo Growers' Cooperative Association	Waldo	Alachua	No	7-29-27	Cooperative Act, 1909	Independent Local	Non-Stock	Strawb's, beans, fertilizers
Webster Growers' Association	Webster	Sumter	No	9-18-29	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Supplies and truck crops
West Pasco Growers' Association	New Pt. Ritchie	Pasco	*	6-15-30	Not Incorporated	Independent Local	Non-Stock	Fertilizers and truck crops
Zephyrhills Vegetable Growers' Association	Zephyrhills	Pasco	No	8-26-21	Gen. Corporation Law	Independent Local	Stock	Truck crops

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CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA—Continued.

LIVESTOCK AND LIVESTOCK PRODUCTS

NAME	Address		Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock cr Non-Stock	Principal Commodities Handled, Services Performe or Activities Proposed
	Post Office	County						
Apalachicola River Valley Beekeepers' Association	Wewahitchka	Gulf	Yes	12-13-29	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Honey
Better Milk Cooperative League	Jacksonville	Duval	Yes	2-21-30	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Collective bargaining
Central Cooperative Marketing Association	Williston	Levy	*	10-4 -30	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Hogs
Central Florida Poultry Producers' Cooperative Association	Orlando	Orange	Yes	3-21-29	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Eggs and poultry
Central Florida Rabbit Growers' Ass'n	Orlando	Orange	Yes	Oct., 1928	Not Incorporated	Independent Local	Non-Stock	Rabbits
Duval County Dairy Association	Jacksonville	Duval	Yes	1926	Not Incorporated	Independent Local	Non-Stock	Dairy supplies
Duval County Poultry Producers' Ass'n	Jacksonville	Duval	No	4-28-25	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Eggs
Escambia County Poultry Exchange	Pensacola	Escambia	Yes	June, 1926	Not Incorporated	Independent Local	Non-Stock	Eggs and poultry
Florida Poultry Association	Havana	Gadsden	Yes	1926	Not Incorporated	Independent Local	Non-Stock	Eggs
Florida Poultry Cooperative	Orlando	Orange	*	7-31-31	Agri. Coop. Act, 1931	Independent Local	Non-Stock	Eggs
Florida West Coast Poultry Association, Incorporated	Bradenton	Manatee	Yes	11-26-27	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Eggs
Gulf Coast Poultry Cooperative	Tampa	Hillsborough	Yes	7-24-29	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Eggs and poultry
Gulf Cooperative Marketing Association	Trenton	Gilchrist	Yes	July, 1930	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Hogs and turkeys
Hardee County Poultry Association	Wauchula	Hardee	No	8-9 -26	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Poultry and eggs
Hernando County Cooperative Dairy	Brooksville	Hernando	No	12-6 -19	Cooperative Act, 1909	Independent Local	Non-Stock	Milk and feed
Highland Poultry Association	Lake Jovita	Pasco	No	Jan., 1926	Not Incorporated	Independent Local	Non-Stock	Eggs and cartons
Hillsborough County Milk Producers' Ass'n	Tampa	Hillsborough	*	July, 1930	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Milk
Jackson County Growers' Cooperative Association	Marianna	Jackson	Yes	Jan., 1930	Not Incorporated	Independent Local	Non-Stock	Poultry
Jefferson County Poultry Association	Monticello	Jefferson	No	1921	Not Incorporated	Independent Local	Non-Stock	Eggs
Kingsway Cooperative Association	Kingsway	Hillsborough	Yes	May, 1930	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Eggs
Leon County Dairymen's Association	Tallahassee	Leon	Yes	Oct., 1927	Not Incorporated	Independent Local	Non-Stock	Feed
Madison County Stock Breeders' Ass'n	Greenville	Madison	No	3-22-22	Cooperative Act, 1909	Independent Local	Non-Stock	Livestock improvement
Miami Home Milk Producers' Association	Miami	Dade	Yes	6-22-28	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Milk
North Brevard Poultry Association	Titusville	Brevard	No	10-18-27	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Eggs
North Florida Poultry Producers' Cooperative Association	Jacksonville	Duval	Yes	1-30-30	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Eggs
North Marion Dairy Association	Reddick	Marion	Yes	1926	Not Incorporated	Independent Local	Non-Stock	Feed
Orange County Milk Producers' Association Formerly Fairvilla Dairies, Incorporated	Orlando	Orange	No	8-20-23	Cooperative Act, 1909	Independent Local	Non-Stock	Feed
Orange County Poultry Association	Orlando	Orange	No	8-31-27	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Eggs
Palm Beach Rabbit Cooperative	W. Palm Beach	Palm Beach	*	9-19-30	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Rabbits
Pinellas Poultry Producers' Association	Largo	Pinellas	No	5-12-28	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Eggs, poultry, feed
Poultry Producers of Polk County, Inc.	Lakeland	Polk	No	4-11-27	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Eggs
Santa Rosa Poultry Producers' Association	Santa Rosa	Walton	Yes	Feb., 1926	Not Incorporated	Independent Local	Non-Stock	Eggs
Sarasota Cooperative Creamery and Poultry Association	Sarasota	Sarasota	No	6-18-28	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Dairy products
South Florida Poultry Cooperative	Ft. Lauderdale	Brevard	*	5-29-30	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Poultry and eggs
West Coast Beekeepers' Association, Inc.	Tampa	Hillsborough	*	8-7 -30	Cooperative Act, 1909	Independent Local	Non-Stock	Honey and supplies

CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA—Continued.

SUBSIDIARIES

NAME	Address Post Office	Address County	Active in 1929-30	Date Organized or Incorporated	Charter Law	Subsidiary of	Stock or Non-Stock	Principal Commodities Handled, Services Perform or Activities Proposed
Capitol Fruit Company	Tampa	Hillsborough	Yes	10-15-27	Gen. Corporation Law	Florida Citrus Exchange	Stock	Low grade citrus fruit.
Domino Citrus Stores	Bradenton	Manatee	Yes	5-1 -30	Cooperative Act, 1909	Bradenton Citrus Growers' Ass'n	Non-Stock	Fruit juice and fancy fruit
Exchange Agricultural Credit Corporation	Miami	Dade	No	6-18-24	Gen. Corporation Law	Dade County Sub-Exchange	Stock	Credit
Exchange Packing Company	Tampa	Hillsborough	Yes	11-20-29	Gen. Corporation Law	Florida Citrus Exchange	Stock	Citrus fruits
Exchange Sales Company	Tampa	Hillsborough	Yes		Gen. Corporation Law	Florida Citrus Exchange	Stock	Fruit and Vegetables
Exchange Supply Company	Tampa	Hillsborough	Yes	7-17-16	Gen. Corporation Law	Florida Citrus Exchange	Stock	Materials and Machinery
Growers' Loan and Guaranty Company Formerly Citrus Growers' Guaranty Co.	Tampa	Hillsborough	Yes	10-16-16	Gen. Corporation Law	Florida Citrus Exchange	Stock	Credit
Hastings Agricultural Credit Corporation	Hastings	St. Johns	Yes	6-6 -25	Gen. Corporation Law	Hastings Potato Growers' Ass'n	Stock	Credit
LaCrosse Agricultural Credit Corporation	LaCrosse	Alachua	Yes	1927	Coop. Mark. Act, 1923	LaCrosse Potato Growers' Ass'n	Stock	Credit
Lee County Agricultural Credit Corporation	Ft. Myers	Lee	Yes	Aug., 1927	Not Incorporated	Lee County Cooperative Growers	Stock	Credit
Manatee County Agricultural Credit Corp.	Bradenton	Manatee	Yes	8-4 -26	Gen. Corporation Law	Manatee County Growers' Ass'n	Stock	Credit
Redland Packing Association	Homestead	Dade	Yes	12-28-25	Cooperative Act, 1909	Redlands Citrus Growers' Ass'n	Non-Stock	Citrus fruits
St. Johns Agricultural Credit Corporation	Hastings	St. Johns	Yes	10-8 -29	Gen. Corporation Law	St. Johns Potato Growers' Ass'n	Stock	Credit
Sanford Growers' Credit Corporation	Sanford	Seminole	Yes	1929	Gen. Corporation Law	Sanford-Oviedo Truck Growers' Ass'n	Stock	Credit

CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA—Continued.

MISCELLANEOUS

NAME	Address		Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Performe or Activities Proposed
	Post Office	County						
American Growers' League	Homestead	Dade	No	8-7 -23	Cooperative Act, 1909	Independent Local	Non-Stock	
Associated Growers of Florida, Incorporated	Ft. Lauderdale	Broward	No	9-4 -29	Coop. Mark. Act, 1923	Independent Local	Non-Stock	
Columbia Farmers' Cooperative Association	Lake City	Columbia	No	5-29-26	Coop. Mark. Act, 1923	Independent Local	Non-Stock	
Columbia Producers' Association	Lake City	Columbia	No	2-15-27	Coop. Mark. Act, 1923	Independent Local	Stock	
Cooperative Citrus Culture Association	Mount Dora	Lake	Yes	4-21-30	Coop. Mark. Act, 1923	Independent Local	Stock	Culture and fertilizers
Crescent City Cooperative Association	Crescent City	Putnam	Yes	9-24-29	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Containers
Crystal Springs Cooperative Company	Crystal Springs	Pasco	No	2-24-12	Cooperative Act, 1909	Independent Local	Non-Stock	Cooperative store
Delray Growers' and Packers' Association	Delray	Palm Beach	No	9-8 -14	Cooperative Act, 1909	Independent Local	Non-Stock	Canning pineapples
Dover Growers' Corporation	Dover	Hillsborough	Yes	1919	Gen. Corporation Law	Independent Local	Stock	Merchandise and strawberri
Eldorado Heights Cooperative Association	Eustis	Lake	No	10-7 -15	Cooperative Act, 1909	Independent Local	Non-Stock	
Farmers' Cooperative Association of Marion County	Ocala	Marion	No	8-12-20	Gen. Corporation Law	Independent Local	Stock	
Farmers' Marketing Association	Orlando	Orange	Yes	1927	Not Incorporated	Independent Local	Non-Stock	Stalls rented
Farmers' Warehouse, Incorporated	Greenwood	Jackson	Yes	Sept., 1929	Gen. Corporation Law	Independent Local	Stock	Peanuts
Florida Agricultural Cooperative Ass'n	Miami	Dade	*	8-29-30	Coop. Mark. Act, 1923		Stock	
Florida Avocado Growers' Exchange	Miami	Dade	Yes	5-3 -28	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Avocadoes
Florida Bulb Growers	Sanford	Seminole	Yes	1927	Not Incorporated	Independent Local	Non-Stock	Tariff protection
Florida Bulb Growers' Association	Jacksonville	Duval	*	4-9 -31	Coop. Mark. Act, 1923		Non-Stock	Bulbs
Florida Cooperative Syrup Association	Grand Ridge	Jackson	*	8-1 -31	Agri. Coop. Act, 1931		Non-Stock	Syrup
Florida Grape Growers' Exchange	Orlando	Orange	*	6-13-31	Agri. Coop. Act, 1931		Non-Stock	Grapes
Florida Growers' Marketing Association	Miami	Dade	No	4-29-27	Coop. Mark. Act, 1923	Independent Local	Non-Stock	
Florida Growers' and Shippers' League	Orlando	Orange	No	4-1 -14	Cooperative Act, 1909	Centralized	Non-Stock	
Florida Pecan Growers' Association	Jacksonville	Duval	*	11-3 -30	Coop. Mark. Act, 1923		Non-Stock	Pecans
Florida Plumosus Growers' Cooperative Association	DeLand	Volusia	Yes	11-13-28	Coop. Mark. Act, 1923	Centralized	Non-Stock	Ferns
Fruitmen's Association	Orlando	Orange	*	12-19-30	Coop. Mark. Act, 1923		Non-Stock	Promote citrus industry
Gadsden County Farmers' Cooperative Association	Quincy	Gadsden	*	8-25-30	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Farm products
Growers' and Shippers' League of Florida	Orlando	Orange	Yes	9-22-26	Cooperative Act, 1909	Centralized	Non-Stock	Transportation problems
Gulf Growers, Incorporated	St. Petersburg	Pinellas	Yes	12-7 -29	Cooperative Act, 1909	Independent Local	Non-Stock	Gladiolus
Gum Turpentine—Rosin Marketing Ass'n	Jacksonville	Duval	*	9-18-30	Coop. Mark. Act, 1923		Stock	Naval stores
Highlands Canning Association	Avon Park	Highlands	*	4-16-31	Coop. Mark. Act, 1923		Non-Stock	Canning citrus
Highlands County Fertilizer Purchasing Association	Sebring	Highlands	Yes	Jan., 1929	Not Incorporated	Independent Local	Non-Stock	Fertilizers

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CLASSIFIED LIST OF COOPERATIVE ASSOCIATIONS ORGANIZED IN FLORIDA—Continued.

MISCELLANEOUS

NAME	Address		Active in 1929-30	Date Organized or Incorporated	Charter Law	Type	Stock or Non-Stock	Principal Commodities Handled, Services Performe or Activities Proposed
	Post Office	County						
Hillcrest Cooperative Association	Avon Park	Highlands	No	5-8 -24	Coop. Mark. Act, 1923	Independent Local	Non-Stock	
Hillsborough Farmers' Cooperative Ass'n	Plant City	Hillsborough	*	5-20-31	Coop. Mark. Act, 1923		Non-Stock	
Indian River and Lake Worth Pineapple Growers' Association	Eden	St. Lucie	No	6-2-1892	Gen. Corporation Law	Independent Local	Stock	Pineapples
Indian River Exchange Canneries	Cocoa	Brevard	*	10-22-30	Coop. Mark. Act, 1923		Stock	Canning citrus
Istachatta Growers' League	Istachatta	Hernando	No	1921	Not Incorporated	Independent Local	Stock	Store and truck crops
Jackson County Farmers' Cooperative Association	Greenwood	Jackson	Yes	1926	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Hay, peanuts and fertilizers
Leon County Farmers' Cooperative Ass'n	Tallahassee	Leon	No	Nov., 1929	Not Incorporated	Independent Local	Stock	
Madison County Farmers' Cooperative Association	Madison	Madison	*	Jan., 1930	Not Incorporated	Independent Local	Non-Stock	
Middle River Cooperative Association	Ft. Lauderdale	Broward	*	6-15-31	Coop. Mark. Act, 1923		Non-Stock	
Orange County Farmers' Cooperative Ass'n	Maitland	Orange	*	6-6 -31	Coop. Mark. Act, 1923		Non-Stock	
Orange County Fern Clearing House Ass'n	Apopka	Orange	No	10-2 -28	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Ferns
Orange County Fern Growers' Association	Apopka	Orange	Yes	6-28-29	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Ferns
Pinellas Cannery	Largo	Pinellas	*	7-16-31	Agri. Coop. Act, 1931		Stock	Canning citrus
Pioneer Pineapple Growers' Association	Ankona	St. Lucie	No	12-8 -09	Cooperative Act, 1909	Federated Local	Non-Stock	Pineapples
Plant City Growers' Association	Plant City	Hillsborough	Yes	June, 1916	Gen. Corporation Law	Independent Local	Stock	M'dse, strawberries, tomatoe
Pompano Cooperative Marketing Ass'n	Pompano	Broward	No	1929	Coop. Mark. Act, 1923	Independent Local	Non-Stock	
Producers' Association, Incorporated	Crestview	Okaloosa	Yes	April, 1927	Gen. Corporation Law	Independent Local	Stock	Blueberries, feed, crates
Ridge Citrus Canners, Incorporated	Lake Wales	Polk	*	July, 1930			Stock	Canning citrus
Ruskin Growers' Association	Ruskin	Hillsborough	No	1-2 -14	Cooperative Act, 1909	Independent Local	Non-Stock	
St. Johns Citrus Growers' Association	Seville	Volusia	Yes	11-9 -29	Coop. Mark. Act, 1923	Independent Local	Non-Stock	Protection or property right
Seminole Bulb Growers' Association	Sanford	Seminole	No	2-3 -27	Cooperative Act, 1909	Independent Local	Non-Stock	Bulbs
Seminole Farmers' Cooperative Association	Sanford	Seminole	*	5-20-31	Coop. Mark. Act, 1923		Non-Stock	
Southern Produce Exchange Association	Ft. Lauderdale	Broward	No	9-19-13	Cooperative Act, 1909	Independent Local	Non-Stock	
Suwannee Cooperative Marketing Ass'n	Luraville	Suwannee	No	1-24-24	Coop. Mark. Act, 1923	Independent Local	Non-Stock	
Tri-County Canning Association	Eustis	Lake	*	8-7 -31	Agri. Coop. Act, 1931		Non-Stock	Canning citrus
West Florida Growers' Association	Chipley	Washington	Yes	11-9 -27	Coop. Mark. Act, 1923	Centralized	Non-Stock	Fertilizers
Winter Haven Canning Association	Winter Haven	Polk	*	7-22-31	Agri. Coop. Act, 1931		Stock	Canning citrus
Winter Haven Fruit Products Association	Winter Haven	Polk	No	8-2 -22	Cooperative Act. 1909		Non-Stock	Canned fruit

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LAWS GOVERNING FLORIDA COOPERATIVE ASSOCIATIONS

FEDERAL LAWS

The Federal Anti-Trust Law of 1890, better known as the Sherman Anti-Trust Act, prohibited contracts, combinations, and conspiracies in restraint of trade in interstate and foreign commerce. Paragraph 3 reads as follows:

> Every contract, combination in the form of trust or otherwise, or conspiracy in restraint of trade or commerce in any territory of the United States or of the District of Columbia, or in restraint of trade between any such territory and another, or between any such territory or territories and any State or States or the District of Columbia, or with foreign nations, or between the District of Columbia and any State or States or foreign nations, is hereby declared to be illegal. Every person who shall make any such contract or engage in any such combination or conspiracy shall be deemed guilty of a misdemeanor, and, on conviction thereof, shall be punished by fine not exceeding $5,000, or by imprisonment not exceeding one year, or by both said punishments, in the discretion of the court.

The United States Supreme Court has repeatedly held that only unreasonable restraints are prohibited by this statute. However, as interpreted by the courts, this law applied as well to farmers' cooperative associations having marketing contracts as to combinations of industrial corporations. This worked an unjustifiable hardship on farmers who wished to form cooperative associations, since it is much more difficult for a farmers' cooperative association to gain monopolistic control of a commodity than for a combination of industrial corporations to do so. Agricultural producers and organized labor, alike, became so dissatisfied with the working of the Sherman Anti-Trust Act that Congress amended it by passing the Clayton Act in 1914.

Section 6 of the Clayton Act reads as follows:

> Sec. 6. That the labor of a human being is not a commodity, or article of commerce. Nothing contained in the anti-trust laws shall be construed to forbid the existence and operation of labor, agricultural, or horticultural organizations, instituted for the purposes of mutual help, and not having capital stock or conducted for profit, or to forbid or restrain individual members of such organization from lawfully carrying out the legitimate objects thereof; nor shall such organization, or the members thereof, be held or construed to be illegal combinations or conspiracies in restraint of trade, under the anti-trust laws.

It will be noted that this Act simply made it legal for certain types of labor, agricultural, or horticultural associations, to exist. Only associations not having capital stock came within its scope, and these were not granted any operating privileges.

As the number of cooperative associations increased and the volume of cooperative business grew, it became obvious that the Clayton Act was not broad enough in scope. Associations requiring a large amount of capital were especially handicapped, because capital stock associations were not protected from the anti-trust laws. Thus they were placed at a disadvantage in the use of one of the most efficient methods of financing known. In order to meet this need, the more comprehensive Capper-Volstead Act became a law, February 18, 1922.

The Capper-Volstead Act granted to associations, corporate or otherwise, with or without capital stock, protection from the anti-trust laws, provided that such associations are operated for the mutual benefit of the members, and conform to one or both of the following requirements:

"First. That no member of the association is allowed more than one vote because of the amount of stock or membership capital he may own therein, or,

"Second. That the association does not pay dividends on stock or membership capital in excess of eight per centum per annum."

It will be noted that the association may comply with either, or with both, of the above provisions. But regardless of which, or if both of the above provisions are complied with, the following requirement must in all cases be met:

"Third. That the association shall not deal in the products of non-members to an amount greater in value than such as are handled by it for members."

This Act specifically states that associations which meet its provisions may be organized either with or without capital stock, and may make all necessary contracts and agreements. It does not affect consumers' cooperatives in any way. The text of the Act is given in the appendix.

The Cooperative Marketing Act of 1926 removed all remaining doubt as to the practices of cooperatives which should be recognized as legitimate. It also makes it clear that there can be certain types of joint action among cooperative associations. Section 5 of this Act reads as follows:

> Persons engaged, as original producers of agricultural products, such as farmers, planters, ranchmen, dairymen, nut or fruit growers, acting together in association, corporate or otherwise, in collectively processing, preparing for market, handling, and marketing in interstate and/or foreign commerce such products of persons so engaged, may acquire, exchange, interpret, and disseminate past, present, and prospective crop, market, statistical, economic, and other similar information by direct exchange between such persons,

and/or such associations or federations thereof, and/or by and through a common agent created or selected by them.

It is clear by this Act that Congress recognizes cooperative business organization to be a legitimate activity to be engaged in by farmers, and reflects the intention of giving them ample power to carry on such organizations effectively.

Since cooperative business is conducted on a non-profit basis, it has long been the contention of cooperative associations that they should for this reason be exempt from the payment of income taxes. This view has been rather generally accepted by income tax officials, who have laid down rulings which define the types of business which shall be considered as non-profit. These rulings were standardized in an amendment to the income tax laws in 1926, and the following provision applying to cooperative associations was adopted:

> Section 231. The following organizations shall be exempt from taxation under this title. . . . (12) Farmers', fruit growers', or like associations organized and operated on a cooperative basis (a) for the purpose of marketing the products of members or other producers, and turning back to them the proceeds of sales, less the necessary marketing expenses, on the basis of either the quantity or the value of the products furnished by them, or (b) for the purpose of purchasing supplies and equipment for the use of members or other persons, and turning over such supplies and equipment to them at actual cost, plus necessary expenses. Exemption shall not be denied any such association because it has capital stock, if the dividend rate of such stock is fixed at not to exceed the legal rate of interest in the state of incorporation or 8 per centum per annum, whichever is greater, on the value of the consideration for which the stock was issued, and if substantially all such stock (other than non-voting preferred stock, the owners of which are not entitled or permitted to participate, directly or indirectly, in the profits of the association, upon dissolution or otherwise, beyond the fixed dividends) is owned by producers who market their products or purchase their supplies and equipment through the association; nor shall exemption be denied any such association because there is accumulated and maintained by it a reserve required by state law or a reasonable reserve for any necessary purpose. Such an association may market the products of non-members in an amount the value of which does not exceed the value of the products marketed for members, and may purchase supplies and equipment for non-members in an amount the value of which does not exceed the value of the supplies and equipment purchased for members, provided the value of the purchases made for persons who are neither members nor producers does not exceed 15 per centum of the value of all its purchases.

This Act exempts both marketing and purchasing associations, whether capital stock or non-stock, from the payment of income taxes, provided profits above operating expenses are returned to the patrons, and that dividends on capital stock are limited to a rate not exceeding the lawful rate of interest or 8 percent, whichever is greater, on the issued value of the stock. Substantially all common stock must be owned by producers who market their products or purchase their supplies and equipment through the association. This is the only one of the Federal laws to recognize consumer cooperation in any way.

The most recent Federal law of importance to cooperative associations is the Agricultural Marketing Act, approved June 15, 1929. This is an Act "to establish a Federal Farm Board to promote the effective merchandising of agricultural commodities in interstate and foreign commerce, and to place agriculture on a basis of economic equality with other industries." The declaration of policy is as follows:

> Section 1. (a) That it is hereby declared to be the policy of Congress to promote the effective merchandising of agricultural commodities in interstate and foreign commerce, so that the industry of agriculture will be placed on a basis of economic equality with other industries, and to that end to protect, control, and stabilize the currents of interstate and foreign commerce in the marketing of agricultural commodities and their food products—
>
> (1) by minimizing speculation.
>
> (2) by preventing inefficient and wasteful methods of distribution.
>
> (3) by encouraging the organization of producers into effective associations or corporations under their own control for greater unity of effort in marketing and by promoting the establishment and financing of a farm marketing system of producer-owned and producer-controlled cooperative associations and other agencies.
>
> (4) by aiding in preventing and controlling surpluses in any agricultural commodity, through orderly production and distribution, so as to maintain advantageous domestic markets and prevent such surpluses from causing undue and excessive fluctuations or depressions in prices for the commodity.
>
> (b) There shall be considered as a surplus for the purposes of this Act any seasonal or year's total surplus, produced in the United States and either local or national in extent, that is in excess of the requirements for the orderly distribution of the agricultural commodity or is in excess of the domestic requirements for such commodity.
>
> (c) The Federal Farm Board shall execute the powers vested in it by this Act only in such manner as will, in the judgment of the board, aid to the fullest practicable extent in carrying out the policy above declared.

The central idea in the Agricultural Marketing Act seems to be to strengthen and extend the cooperative movement. Under this Act, cooperative associations are not only to be granted immunity from the anti-trust laws, but are to be given aid in setting up efficient marketing systems. This aid is to be given in the form of actual financial assistance in the form of loans, as well as information and advice.

The Act provides for a revolving fund of $500,000,000, and additional appropriation for current expenditures, to be administered by a board of eight members and the Secretary of Agriculture. The board is authorized to make such expenditures to execute its functions as are necessary, and for research and extension work in connection with the development and strengthening of cooperative associations; to make loans to cooperative associations and stabilization corporations, and for price insurance to cooperative associations. The types of loans to be made to cooperative associations and provisions governing them are as follows:

Section 7. (a) Upon application by any cooperative association the board is authorized to make loans to it from the revolving fund to assist in

(1) the effective merchandising of agricultural commodities and food products thereof;

(2) the construction or acquisition by purchase or lease of physical marketing facilities for preparing, handling, storing, processing, or merchandising agricultural commodities or their food products;

(3) the formaton of clearing house associations;

(4) extending membership of the cooperative association applying for the loan by educating the producers of the commodity handled by the association in the advantages of cooperative marketing of that commodity; and

(5) enabling the cooperative association applying for the loan to advance to its members a greater share of the market price of the commodity delivered to the association than is practicable under other credit facilities.

(b) No loan shall be made to any cooperative association unless, in the judgment of the board, the loan is in furtherance of the policy declared in section 1 and the cooperative association applying for the loan has an organization and management, and business policies, of such character as to insure the reasonable safety of the loan and the furtherance of such policy.

(c) Loans for the construction or acquisition by purchase or lease of physical facilities shall be subject to the following limitations:

(1) no such loan for the construction or purchase of such facilities shall be made in an amount in excess of 80 per centum of the value of the facilities to be constructed or purchased;

(2) no loan for the purchase or lease of such facilities shall be made unless the board finds that the purchase price or rent to be paid is reasonable;

(3) no loan for the construction, purchase, or lease of such facilities shall be made unless the board finds that there are not available suitable existing facilities that will furnish their services to the cooperative association at reasonable rates; and in addition to the preceding limitation, no loan for the constructon of facilities shall be made unless the board finds that suitable existing facilities are not available for purchase or lease at a reasonable price or rent.

(d) Loans for the construction or purchase of physical facilities, together with interest on the loans, shall be repaid upon an amortization plan over a period not in excess of twenty years.

Section 8. (a) Loans to any cooperative association or stabilization corporation and advances for insurance purposes shall bear interest at a rate of interest per annum equal to the lowest rate of yield (to the nearest one-eighth of 1 per centum) of any Government obligation bearing a date of issue subsequent to April 6, 1917 (except postal-savings bonds), and outstanding at the time the loan agreement is entered into or the advance is made by the board, as certified by the Secretary of the Treasury to the board upon its request: **Provided**, that in no case shall the rate exceed 4 per centum per annum on the unpaid principal.

(b) Payments of principal or interest upon any such loan or advance shall be covered into the revolving fund.

(c) Loans to any cooperative association or stabilization corporation shall be made upon the terms specified in this Act and upon such other terms not inconsistent therewith and upon such security as the board deems necessary.

(d) No loan or insurance agreement shall be made by the board if in its judgment the agreement is likely to increase unduly the production of any agricultural commodity of which there is commonly produced a surplus in excess of the annual marketing requirements.

The Board has actively exercised its powers to make loans (both facility and commodity) to cooperative associations and has established two stabilization corporations; namely, the Grain Stabilization Corporation, and the Cotton Stabilization Corporation. It has also through loans to the Land O'Lake Creameries (incorporated) enabled that organization to engage in butter stabilization operations. It has not, however, attempted to insure cooperatives against price declines nor were any loans made for the purpose of forming clearing house associations.

There have been suggestions at times that there should be a Federal statute for the incorporation of cooperative associations. No general movement has materialized, however, so the powers of incorporation have been left to the individual states. Federal legislation has been concerned with the restraint of trade issue and with various aids to agriculture.

STATE LAWS

Whereas the Federal acts exempt cooperative associations, when they have complied with certain regulations, from paying income taxes and from being viewed as operating in restraint of trade, State acts deal primarily with methods of control, property rights, restrictions of transfer of certificates of membership or capital stock, rights to make specific kinds of contracts between the association and its members, as well as operation in restraint of trade within the state.

Before there was any Federal legislation favoring cooperative associations many of the states had provided special acts for the benefit of cooperative associations. The need for special legislation for cooperative associations was apparent because it was difficult under the general corporation laws of the various states to operate an association primarily for the benefit of its users. There are three reasons why this was true. First, cooperative associations could not restrict the transfer of stock to non-patrons. Second, they could not limit the amount of stock held by one person. Third, no method of control was provided other than on a share basis. Consequently stock often drifted into the hands of a few who were more interested in operating the association for profit than for rendering service to the patrons.

In 1868 Massachusetts passed an Act in which it was provided that no one be allowed to own more than $1,000 worth of stock or have more than one vote, and denied the privilege of becoming a shareholder to any one not accepted by the management of the association.

In 1895 California passed the first non-stock act. This Act provided for the issue of certificates of membership. No member had more than one vote and the Act stipulated definitely that "the rights and interest of all members shall be equal and no member can have or acquire a greater interest therein than any other member has."

These laws as well as early laws passed by many other states indicate the effort that was being made to provide a law that would more nearly meet the needs of farmer cooperative corporations.

In 1909 Florida passed her first cooperative marketing act. It was for the incorporation of non-stock associations which restricted their membership to producers of agricultural commodities, and required that they be controlled on the basis of one member one vote. If the property rights and interests of the members were not equal the articles of incorporation must provide a rule or rules whereby they could be determined. In 1917 a second cooperative marketing act was passed which permitted the use of capital stock but had no provision for non-stock organizations. Through its articles of incorporation or its by-laws an association incorporated under this Act may specify its basis of control, limit the amount of stock to be owned by one person and make provision for distributing its profits or savings which must be done either in part or wholly upon a patronage basis.

Florida passed a third Act in 1923 which provided for the incorporation of either capital stock or non-stock associations. This Act was repealed by "The Agricultural Cooperative Act" of 1931. The 1931 Act, like the 1923 Act, has provisions for the incorporation of either capital stock or non-stock associations. It is similar in many other respects and in some instances is copied verbatim, but in general it is somewhat broader than the 1923 Act. The 1923 Act confined its business to members only, required one member one vote as the basis of control and limited contracts between association and members to a period of not more than ten years. The 1931 Act permits business with non-members to an amount of 50 percent of the total business, provides that capital stock associations may control their business on either a "patronage" or "one member one vote" basis, and does not limit contracts between association and members to any period of years.

A comparison of important features of the three cooperative marketing acts of Florida which are now in effect is given on pages 30 to 32, inclusive. These Acts are quoted in full in the appendix.

Since "The Agricultural Cooperative Act" of 1931 limits dividends on capital stock to not more than 8 percent and restricts its business with non-members to not more than 50 percent of the total business it meets the requirements of the Capper-Volstead Act. It fails to conform to section 231 of the Federal Income Tax law only in that it does not limit purchases made for persons who are neither members nor producers to 15 percent of the total purchases.

The 1909 Act does not conform to the Capper-Volstead Act because it has no restriction on non-member business.

The 1917 Act does not conform to the Capper-Volstead Act in that it neither limits dividends on capital stock nor has any limit on business done with non-members. Neither the 1917 Act nor the 1909 Act conforms to section 231 of the Federal Income Tax law.

Although the 1909 and 1917 Acts do not conform with the Capper-Volstead Act and section 231 of the Federal Income Tax law, there is nothing to prevent cooperative associations organized under either of these Acts from meeting the requirements of the Federal cooperative laws.

Prior to 1909 cooperative associations were required to incorporate under the general corporation laws of the state which were first passed in 1868 and which had few changes or amendments prior to 1909. Cooperative associations may still incorporate under the general corporation laws, but they necessarily subject themselves to the payment of filing fees and the annual franchise tax on corporations as well as the restriction of their operations to conform with the provisions of the general corporation laws.

COMPARISON OF IMPORTANT FEATURES OF THE COOPERATIVE MARKETING ACTS OF FLORIDA IN EFFECT IN 1931.

Features	"The Agricultural Cooperative Act"	Compiled General Laws of Florida, 1927 — Annotated —Volume 3, Sections 6385 to 6390—Cooperative Associations	Compiled General Laws of Florida, 1927 — Annotated — Volume 3, Sections 6509 to 6515—Agricultural and Horticultural Associations
Year enacted	1931	1917	1909
Publication of articles of incorporation	Not required	Required	Required
Filing fees	$10.00	$2.00	$3.50
Period to exist	Not more than 50 years	Indefinite	Not more than 50 years
Qualification for membership	By-laws may limit members to producers of agricultural products and to associations as defined in this Act	None except as specified in by-laws	Members must be limited to producers of agricultural products or engaged in the activities permitted by this Act
Number required to form association	Three or more	Ten or more	Three or more
Number of directors	Three or more	According to articles of incorporation or by-laws	Three or more
Election of officers	Directors elect officers — president and vice-president must also be directors	Not specified	Not specified
Ownership in other corporations	May own stock in any related association or corporation	May own stock in any other corporation	May own stock only in corporations that operate solely for the benefit or advancement of the interest of persons engaged in agriculture
Property rights	If stock, share basis. If non-stock, must state if property rights are equal or unequal—if unequal rules must be stated as to how property rights are determined	Stock share basis	Articles of incorporation must state if property rights are equal or unequal—if unequal, rules must be set forth by which the property interest of the members is determined

COMPARISON OF IMPORTANT FEATURES OF THE COOPERATIVE MARKETING ACTS OF FLORIDA IN EFFECT IN 1931.—Continued.

Features	"The Agricultural Cooperative Act"	Compiled General Laws of Florida, 1927—Annotated—Volume 3, Sections 6385 to 6390—Cooperative Associations	Compiled General Laws of Florida, 1927—Annotated—Volume 3, Sections 6509 to 6515—Agricultural and Horticultural Associations
Control	If non-stock, one member one vote—if capital stock, may permit voting on patronage basis	As the stockholders of the association designate	One member one vote unless specified otherwise in the articles of incorporation
Capital stock or non-stock	Either	Stock	Non-stock
Dividends on capital stock	Dividends limited to 8 percent per year	By-laws may limit dividends on capital stock	Non-stock—but interest on bonds limited to 8 percent per year
Ownership of capital stock	No member may own more than one-third of the total common stock—by-laws may further limit amount of stock held by one member	Unlimited unless articles of incorporation or by-laws provide for limitations	Non-stock
Patronage dividend	Yes—after a maximum of 8 percent on common stock has been paid and proper reserves are set aside, the remainder of the profits (savings) must be distributed on basis of patronage	Must be in part or wholly on a patronage basis	Since non-stock dividends would be paid on patronage basis
Reserves	Reserves are permissible but not mandatory	Reserves are permissible but not mandatory	Reserves are permissible but not mandatory
Distribution of reserves	Reserves must be distributed on patronage basis	By-laws provide for distribution of reserves either wholly or in part on basis of patronage	Articles of incorporation must make provision for distribution of reserves or they are distributed on an equal basis
Non-member business	Non-member business is permitted up to 50 percent of the total business	No limit placed on non-member business	No limit placed on non-member business

COMPARISON OF IMPORTANT FEATURES OF THE COOPERATIVE MARKETING ACTS OF FLORIDA IN EFFECT IN 1931.—Continued.

Features	"The Agricultural Cooperative Act"	Compiled General Laws of Florida, 1927—Annotated—Volume 3, Sections 6385 to 6390—Cooperative Associations	Compiled General Laws of Florida, 1927—Annotated—Volume 3, Sections 6509 to 6515—Agricultural and Horticultural Associations
Contracts:		No provision for contracts between association and members	
(a) Purchase and sale or agency	Either		Either
(b) Period contract may run	No limit		Not more than 10 years
(c) Liquidated damages provision	Specified sums may be fixed in contract and by-laws as liquidated damages		Specified sums may be fixed in contract and/or by-laws as liquidated damages
(d) Injunctions	In case contract is violated the association is entitled to an injunction		In case contract is violated the association is entitled to an injunction
Liability of members	Liable only for debts to the association and unpaid membership fees and subscription on stock	No provision other than that applying to general corporations	As provided in by-laws
Provisions for dissolution	May be dissolved by two-thirds vote of the members or by the holders of two-thirds of the common stock	No provisions	May be dissolved by two-thirds vote of members

APPENDIX

The exact texts of the Capper-Volstead Act and all Florida Acts relating to cooperative associations are given in the following pages:

THE CAPPER-VOLSTEAD ACT

An Act to Authorize Association of Producers of Agricultural Products.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled. That persons engaged in the production of agricultural products as farmers, planters, ranchmen, dairymen, nut or fruit growers may act together in associations, corporate or otherwise, with or without capital stock, in collectively processing, preparing for market, handling, and marketing in interstate and foreign commerce, such products of persons so engaged. Such associations may have marketing agencies in common; and such associations and their members may make the necessary contracts and agreements to effect such purposes; **Provided, however,** that such associations are operated for the mutual benefit of the members thereof, as such producers, and conform to one or both of the following requirements:

1st. That no member of the association is allowed more than one vote because of the amount of stock or membership capital he may own therein, or,

2nd. That the association does not pay dividends on stock or membership capital in excess of eight per centum per annum.

And in any case to the following:

3rd. That the association shall not deal in the products of non-members to an amount greater in value than such as are handled by it for members.

Section 2. That if the Secretary of Agriculture shall have reason to believe that any such association monopolizes or restrains trade in interstate or foreign commerce to such an extent that the price of any agricultural product is unduly enhanced by reason thereof, he shall serve upon such association a complaint stating his charge in that respect, to which complaint shall be attached, or contained therein, a notice of hearing, specifying a day and place not less than thirty days after the service thereof, requiring the association to show cause why an order should not be made directing it to cease and desist from monopolization or restraint of trade. An association so complained of may at the time and place so fixed show cause why such order should not be entered. The evidence given on such hearing shall be taken under such rules and regulations as the Secretary of Agriculture may prescribe, reduced to writing, and made a part of the record therein. If upon such hearing the Secretary of Agriculture shall be of the opinion that such association monopolizes or restrains trade in interstate or foreign commerce to such an extent that the price of any agricultural product is unduly enhanced thereby, he shall issue and cause to be served upon the association an order reciting the facts found by him, directing such association to cease and desist from monopolization or restraint of trade. On the request of such association or if such association fails or neglects for thirty days to obey such order, the Secretary of Agriculture shall file in the district court in the judicial district in which such association has its principal place of business a certified copy of the order and of all the records in the proceedings, together with a petition asking that the order be enforced, and shall give notice to the Attorney General and to said association of such filing. Such district court shall thereupon have jurisdiction to enter a decree affirming, modifying, or setting aside said order, or enter such other decree as the court may deem equitable, and may make rules as to pleadings and proceedings to be had in considering such order. The place of trial, may, for cause or by consent of parties, be changed as in other causes.

The facts found by the Secretary of Agriculture and recited or set forth in said order shall be prima facie evidence of such facts, but either party may adduce additional evidence. The Department of Justice shall have charge of the enforcement of such order. After the order is so filed in such district court and while pending for review therein the court may issue a temporary writ of injunction forbidding such association from violating such order or any part thereof. The court may, upon conclusion of its hearing, enforce its decree by a permanent injunction or other appropriate remedy. Service of such complaint and of all notices may be made upon such association by service upon any officer or agent thereof engaged in carrying on its business, or on any attorney authorized to appear in such proceedings for such association, and such service shall be binding upon such association, the officers, and members thereof. Approved, February 18, 1922.

COOPERATIVE LAW OF 1909

Compiled General Laws of Florida, 1927
Annotated
Volume 3, Sections 6509 to 6515

Agricultural and Horticultural Associations

Section 6509. Forming non-profit co-operative association; powers.—Three or more persons engaged in the production, preserving, drying, packing, canning, bottling, shipping or marketing of agricultural, viticultural or horticultural products, or all or any of them, or in the manufacture or preparation of any confection, extracts, oils, juices or by-products, or any or all of them, may form a non-profit co-operative association under the provisions of this Article to carry on said business, and such associations shall have and may exercise powers authorized by this Article, and powers necessarily incidental thereto and all other powers granted to private corporations by the laws of this State, except such powers as are inconsistent with those granted by this Article.

No association organized hereunder shall be deemed to be a combination in restraint of trade or an illegal monopoly; or an attempt to lessen competition or fix prices arbitrarily, nor shall the marketing contracts or agreement between the association and its members, or any agreements authorized in this Article be considered illegal or in restraint of trade. (Ch. 5958, June 8, 1909, Section 1.)

Section 6510. Not to have capital stock; not for profit; membership; membership not assignable; directors may consent to assignment.—Such association shall not have a capital stock, and its business shall not be carried on for profit. Any person, or any number of persons, in addition to the original incorporators, may become members of such association, upon such terms and conditions as to membership, and subject to such rules and regulations as to their, and each of their, contract and other rights and liabilities between it and the member, as the said association shall provide in its bylaws. The association shall issue a certificate of membership to each member, but the said membership, or the said certificate thereof, shall not be assigned by a member to any other person, nor shall the assigns thereof be entitled to membership in the association or to any property rights or interest therein. Nor shall a purchaser at execution sale, or any other person who may succeed, by operation of law or otherwise, to the property interests of a member, be entitled to membership or become a member of the association by virtue of such transfer. The board of directors may, however, by motion duly adopted by it, consent to such assignment or transfer and to the acceptance of the assignee or transferee as a member of the association, but the association shall have the right, by its by-laws, to provide for or against the transfer of membership and for or against the assignment of membership certificates, and also the terms and conditions upon which any such transfer or assignment shall be allowed. (Ch. 5958, June 8, 1909, Section 2.)

Section 6511. Articles of incorporation.—Each association formed under this Article must prepare and file articles of incorporation in the same manner and under the same regulations as now required by law for the incorporation of companies for profit in this State, and therein shall set forth:

1. The name of the association.
2. The purpose for which it is formed.
3. The place where its principal business will be transacted.
4. The term for which it is to exist, not exceeding fifty years.
5. The number of directors thereof, which must not be less than three and which may be any number in excess thereof, and the names and residences of those selected for the first year and until their successors shall have been elected and shall have accepted office.
6. Whether the voting power and the property rights and interest of each member shall be equal, or unequal, and if unequal these articles shall set forth a general rule or rules applicable to all members by which the voting power and the property rights and interests, respectivey, of each member may and shall be determined and fixed, but the association shall have power to admit new members, who shall be entitled to vote and to share in the property of the association with the old members, in accordance with such general rule. This provision of the articles of incorporation shall not be altered, amended or repealed except by the unanimous written consent or the vote of all the members.
7. Said articles must be subscribed by the original members and acknowledged by one of them before an officer authorized by the law of this State to take and certify acknowledgments of deeds of conveyance, and shall be filed in accordance with the provisions of law, and when so filed the said articles of incorporation or certified copies thereof shall be received in all the courts of this State and other places as prima facie evidence of the facts contained therein. (Id., Section 3.)

Section 6512. By-laws.—Each association incorporated under this Article must, within thirty days after its incorporation, adopt a code of by-laws for its government and management not inconsistent with the provisions of this law. A majority vote of the members or the written assent of members representing a majority of the votes, is necessary to adopt such by-laws. The provisions of the general laws of this State not inconsistent with the provisons of this Article shall apply to the by-laws of the corporation provided for in this Article. Each association may also, by its by-laws adopted as aforesaid, provide for the following matters:

1. The manner of removal of any one or more of its directors, and for filling any and all vacancies in the board of directors.
2. The number of directors and the number of members or votes thereof constituting a quorum.
3. The conditions upon which, and the time when, membership of any member in the associaton shall cease; the mode, manner and effect of expulsion of a member, subject to the right of the expelled member to have the

board of directors (equitably) appraise his property interests in the association and to affix the amount thereof in money, and to have the money paid to him within sixty days after such expulsion.

4. The amount of membership fee, if any, and the amount which each member shall be required to pay annually, or from time to time, if at all, to carry on the business of the association, and also the compensation, if any, to be paid by each member for any services rendered by the association to him, and the time of payment and the manner of collecting the same, and for forfeiture of the interest of the member in the association for non-payment of the same.

5. The number and qualification of members of the association and the conditions precedent to membership, and the method, time and manner of permitting members to withdraw, and providing for the assignment and transfer of interest of the member, and the manner of determining the value of such interest, and providing for the purchase of such interest by the association upon the death, withdrawal or expulsion of a member or upon the forfeiture of his membership, at the option of the association.

6. Permitting members to vote by their proxies and determining the conditions, manner, form and effect thereof. (Id., Section 4.)

Section 6513. Special powers; marketing contracts; voluntary dissolution.—Each association incorporated under this Article shall have the powers granted by the provisions of this law and other laws of Florida relating to private corporations, and shall also have the following powers:

1. To appoint such agents and officers as its business may require, and such appointed agents may be either persons or corporations; to admit persons to membership in the association, and to expel any member pursuant to the provisions of its by-laws; to forfeit the membership of any member for violation of any agreement between him and the association, or for his violation of its by-laws.

2. To purchase or otherwise acquire, hold, own, sell and otherwise dispose of any and every kind or kinds of real and personal property necessary to carry on its business, and to acquire by purchase or otherwise the interest of any member in the property of the association.

3. Upon the written assent or by a vote of members representing two-thirds of the total votes of all members to co-operate with any other co-operative corporation or corporations for the co-operative and more economical carrying on of their respective business, by consolidation; upon resolution adopted by its board of directors, to enter into all necessary and proper contracts and agreements, and to make all necessary and proper stipulations and arrangements with any other co-operative corporation or corporations, for the co-operative and more economical carrying on of its business, or any part or parts thereof; or any two or more co-operative corporations organized under this Title, upon resolution adopted by their respective boards of directors, may for the purpose of more economically carrying on their respective business, by agreement between them, unite in employing and using, or several associations may separately employ and use, the same methods, means and agencies for carrying on and conducting their respective businesses.

4. To organize, form, operate, own, control, have interest in, own stock of or be a member of any other corporation or corporations, with or without capital stock, and engaged in preserving, drying, processing, canning, picking, hauling, packing, storing, handling, shipping, utilizing, manufacturing, marketing or selling any of the agricultural or horticultural products handled by the association, or the by-products thereof.

5. To make and execute marketing contracts requiring the members to sell, for any period of time, not over ten years, all or any specified part of their agricultural or horticultural products exclusively to or through the

association or any facilities to be created by the association. The contracts may provide that the association may sell or resell the products of its members with or without taking title thereto, and pay over to its members the sale or resale price, after deducting all necessary selling, overhead and other costs and expenses, including interest on bonds, not exceeding eight per cent. per annum and reserves for retiring the bonds, if any, and other proper reserves.

6. Either the by-laws or the marketing contracts, or both the said by-laws and marketing contracts may fix, as liquidated damages, specific sums to be paid by the member to the association upon the breach by him of any provision of the marketing contract regarding the sale or delivery or withholding of products; and may further provide that the member will pay all costs, premiums for bonds, expenses and fees in case any action is brought upon the contract by the association, and any such provisions shall be valid and enforcible in the courts of this State.

7. In the event of any breach or threatened breach of a marketing contract by a member, the association shall be entitled to an injunction to prevent the further breach of the contract, and to a decree of specific performance thereof. Pending the adjudication of such an action and upon filing a verified complaint showing the breach or threatened breach, and upon filing a sufficient bond, the association shall be entitled to a temporary restraining order and a preliminary injunction against the member.

8. Any association formed or consolidated under this Article may be dissolved and its affairs wound up voluntarily by the written request of members representing two-thirds of the total votes, in the manner and with the effect now provided by law, except that the moneys remaining after liquidation shall be divided among the members in proportion to their property interests therein. (Ch. 5958, June 8, 1909, Section 5; Ch. 10097, Acts 1925, Section 2.)

Section 6514. May own stock in certain corporations.—Any agricultural or horticultural non-profit, co-operative association, heretofore, or hereafter, organized under the laws of the State of Florida, may own or hold stock in any corporation organized under the laws of the State of Florida, if such corporation is organized, or conducts, or operates, its business, solely for the benefit or advancement of the interests of persons engaged in agricultural or horticultural pursuits in this State. (Ch. 7383, 1917, Section 1.)

Section 6515. Quo warranto to test validity of incorporation.—The right of an association claiming to be organized and incorporated and carrying on its business under this Article to do and to continue its business, may be inquired into by quo warranto at the suit of the Attorney-General, but not otherwise. (Ch. 5985, June 8, 1909, Section 6.)

COOPERATIVE LAW OF 1917

Compiled General Laws of Florida, 1927
Annotated
Volume 3, Sections 6385 to 6390

Incorporation of Co-operative Associations

Section 6385. "Co-operative association" defined.—For the purpose of this Sub-Chapter, the words "co-operative company, corporation or association" are defined to mean a company, corporation or association which authorizes the distribution in part or wholly, on the basis of, or in proportion to, the amount of property bought from or sold to members, and other customers, or of labor performed, or other service rendered to the corporation. (Ch. 7384, Acts 1917, Section 1.)

Section 6386. Number of persons required.—Any number of persons, not less than ten may be associated and incorporated for the co-operative transaction of any lawful business, irrigation ditches, bridges and other works of internal improvement. (Id., Section 2.)

Section 6387. General powers.—Every co-operative corporation as such, has power:

1. To have succession by its corporate name.
2. To sue and be sued, to complain and defend in the courts of law and equity.
3. To make and use a common seal, and alter same at pleasure.
4. To hold personal estate, and all such real estate as may be necessary for the legitimate business of the corporation.
5. To regulate and limit the right of stockholders to transfer their stock.
6. To appoint such subordinate officers and agents as the business of the corporation shall require, and to allow them suitable compensation therefor.
7. To make by-laws, for the management of its affairs and provide therein the terms and limitations of stock ownership, and for the distribution of its earnings. (Id., Section 3.)

Section 6388. Powers, where not specified.—The powers enumerated in the preceding section shall vest in every cooperative corporation in this State, whether the same be formed without, or by legislative enactment, although that may not be specified in the charter or in its articles of association. (Id., Section 4.)

Section 6389. Incorporation fees; issuance of charter.—The fees for the incorporation of co-operative corporations or associations shall be the same amount as those provided for like capitalization of general corporations in the State of Florida: Provided, that any co-operative corporation or association being such under the definition given under Section 6385 is hereby authorized to file with the Secretary of State a declaration signed by its president and secretary stating that it is a co-operative corporation or association as above defined, who shall issue to said corporation a charter in the usual form, and from and after the filing of such declaration with the Secretary of State, and the issuance of said charter, it shall be entitled to the same legal recognition as other corporations organized under the laws of this State, and the fee for filing such declaration shall be two dollars. (Id., Section 5.)

Section 6390. Stockholders may govern by co-operative custom.—The stockholders of any co-operative association or business can under the provisions of this Sub-Chapter govern the association or business by purely cooperative custom, of one man, one vote, this however to be left optionary with the stockholders of the association. (Id., Section 6.)

THE AGRICULTURAL COOPERATIVE ACT, 1931

(Florida Senate Bill No. 396.)

Section 1. That Chapter 9300 of the Acts of the Legislature of 1923, entitled "An Act to Encourage the Co-operative Marketing of Farm Products, and to Authorize the Incorporation of Co-operative Marketing Associations" be and the same is hereby amended to read as follows:

"Section 2. Declaration of Policy.—In order to promote, foster and encourage the intelligent and orderly marketing of agricultural products through cooperation; and to eliminate speculation and waste; and to make the distribution of agricultural products between producer and consumer as direct as can be efficiently done; and to stabilize the marketing of agricultural products, this Act is passed."

Section 2. Definitions.—As used in this Act.

(a) The term "agricultural products" shall include horticultural, viticultural, forestry, dairy, live stock, poultry, bee and any farm products;

(b) The term "member" shall include actual members of associations without capital stock and holders of common stock in associations organized with capital stock;

(c) The term "association" means any corporation organized under this Act or any corporation formed under any general or special Act of this or any other State as a cooperative association, organized for the mutual benefit of its members either as producers of agricultural products or as non-profit cooperative organizations of producers of agricultural products, or both, and in which the return on the stock or membership capital is limited to an amount not to exceed eight per centum (8%) per annum, and in which during any fiscal year thereof the value of business done with non-members shall not exceed the business done with members during the same period.

(d) The term "person" shall include individuals, firms, partnerships, corporations and associations.

(e) Associations organized hereunder shall be deemed "non-profit", inasmuch as they are not organized to make profit for themselves, as such, or for their members, as such, but only for their members as producers.

(f) For the purpose of brevity and convenience, this Act may be indexed, referred to and cited as "The Agricultural Cooperative Act."

Section 3. Who May Organize.—Three or more persons engaged in the production of any agricultural products, or three or more associations, may form a non-profit cooperative association under the provisions of this Act.

Section 4. Purposes.—An association may be organized under this Act for the purpose of engaging in any cooperative activity in connection with the producing, marketing or selling of agricultural products; or with the growing, harvesting, preserving, drying, processing, canning, packing, grading, storing, warehousing, handling, shipping, or utilizing such products; or the manufacturing or marketing of the by-products thereof; or in connection with any of the activities mentioned herein, the manufacturing, selling or supplying of machinery, equipment or supplies; or in the financng of any of the above enumerated activities; or in performing or furnishing business or educational services, on a cooperative basis for those engaged in agriculture as bona fide producers of agricultural products, or in any one or more of the activities specified herein.

Section 5. Preliminary Investigation.—Every group of persons contemplating the organization of an association under this Act is urged to communicate with the State Market Commissioner, who will inform it whatever a survey of the marketing conditions affecting the commodities to be handled by the proposed association indicates regarding probable success.

Section 6. Powers.—Except as the same be limited in its articles of incorporation, each association organized under this Act shall have the following powers:

(a) To engage in any activity in connection with the producing, marketing, selling, preserving, growing, harvesting, drying. processing, manufacturing, canning, packing, grading, warehousing, storing, handling or utilizing of agricultural products, or in the manufacturing or marketing of the by-products thereof; or in any activities in connection with the manufacturing, purchasing, hiring or using supplies, machinery or equipment; or in the financing of any of the above enumerated activities, or in performing business or educational services, on a cooperative basis, for those engaged in agriculture as bona fide producers of agricultural products; or in any one or more of the activities specified herein;

(b) To borrow money from any source without limitation as to amount of corporate indebtedness or liability, with authority to give any kind or form of obligation or security therefor.

(c) To act as the agent or representative of any person or persons in any of the above mentioned activities;

(d) To make loans or advances to members and to their members, to non-member patrons, and to non-member patrons of members, with authority to accept therefor any kind, form or type of obligation with or without security; to purchase, endorse, discount, sell or guarantee the payment of any note, draft, bill of exchange, indenture, bill of sale, mortgage, or other obligation, the proceeds of which have been advanced or used in the first instance for any of the purposes provided for herein; to discount for or purchase from any association organized under the laws of any state, with or without its endorsement, any note, draft, bill of exchange, indenture, bill of sale, mortgage, or other obligation, the proceeds of which are advanced or used in the first instance for carrying on any cooperative activity authorized in this Act and with authority to dispose of same with or without endorsement. An association organized under this Act and exercising any of the powers provided in this paragraph, shall not engage in the business of banking;

(e) To purchase or otherwise acquire, to hold, own and exercise all rights of ownership in, and to sell, transfer, pledge, or guarantee the payment of dividends or interest on, or the retirement or redemption of, shares, of capital stock, bonds or other obligations of any corporation or association, engaged in any directly or indirectly related activity, or in the producing, picking, hauling, packing, shipping, handling, warehousing, financing, canning, preserving, processing, manufacturing, utilizing, marketing, or selling of any of the products handled by the association, or any by-products thereof.

(f) To establish reserves and to invest the funds thereof in bonds, or in such other property as may be provided in the by-laws;

(g) To buy, hold and exercise all privileges of ownership over such real or personal property, as may be necessary or convenient for the conduct and operation of any of the business of the association, or incidental thereto;

(h) To sell, convey and transfer all of the assets of the association; provided, such sale shall be consented to by not less than two-thirds of its members or by the holders of not less than two-thirds of its common stock, which consent shall be given either in writing, or by vote at a special meeting of its members or stockholders called for that purpose;

(i) To establish, secure, own and develop patents, trade-marks and copyrights;

(j) To do each and everything necessary, suitable or proper for the accomplishment of any one of the purposes, or the attainment of any one or more of the objects herein enumerated, or conducive to or expedient for the interest or benefit of the association, and to contract accordingly; and in addition, to exercise and possess all powers, rights and privileges necessary or incidental to the purposes for which the association is organized, or to the activities in which it is engaged, and any other rights, powers and privileges granted by the laws of this State to corporations for profit, except such as are inconsistent with the express provisions of this Act; and to do any such thing anywhere;

(k) No association organized under this Act, during any fiscal year thereof, shall deal in products, handle machinery, equipment, or supplies or perform services for and on behalf of non-members to an amount greater in value than such as are dealt in, handled or performed by it for and on behalf of members during the same period.

Section 7. Members.—(a) Under the terms and conditions prescribed in the by-laws adopted by it, an association may admit as members, or issue common stock only to persons engaged in the production of agricultural products and to associations as herein defined.

(b) An association organized hereunder may become a member or stockholder of any other association or corporation.

Section 8. Articles of Incorporation.—Each association organized under this Act shall prepare and file articles of incorporation setting forth:

(a) The name of the association, which may or may not include the word cooperative, or any abbreviation thereof;

(b) The purpose for which it is formed;

(c) The place where its principal office within the State will be located;

(d) The term for which it is to exist, not exceeding fifty (50) years;

(e) The minimum number of directors thereof, which must not be less than three (3) and may be any number in excess thereof; the method by which the number of directors may be increased or decreased; the term of office of such directors, and the names and addresses of those who are to serve as incorporating directors for the first term or until the election and qualification of their successors;

(f) If organized without capital stock, whether the property rights and interest of each member shall be equal or unequal; if unequal, the general rule or rules applicable to all members by which the property rights and interest, respectively, of each member may and shall be determined and fixed; and provision for the admission of new members, who shall be entitled to share in the property of the association with the old members, in accordance with such general rule or rules. This provision or paragraph of the articles of incorporation shall not be altered, amended or repealed, except by the written consent or vote of three-fourths of the members;

(g) If organized with capital stock, the amount of such stock and the number of shares into which the capital stock is to be divided, whether all or part of the same shall have a par value, and if so, the par value thereof, whether all or part of the same shall have no par value, and if there is to be more than one class of stock created, a description of the different classes, the number of shares in each class, and the relative rights, interests and preferences each class shall represent;

(h) In addition to the foregoing, the articles of incorporation of any association incorporated hereunder may contain any provision consistent with law with respect to management, regulation, government, financing, indebtedness, membership, the establishment of voting districts and the election of delegates for representative purposes, the issuance, retirement and transfer of its stock, if formed with capital stock, or any provisions relative to the way or manner in which it shall operate or with respect to its members, officers or directors and any other provisions relating to its affairs.

The articles shall be subscribed by the incorporators and acknowledged by one of them, if individuals, or by the president or any vice-president of one of them, if corporations, before an officer authorized by law to take and certify acknowledgements of deeds and conveyances, and shall be filed in the office of the Secretary of State accompanied by a fee of ten dollars ($10.00) which shall be the only fee required therefor, and thereupon the association shall be and constitute a body corporate under the provisions of this Act, and a copy of said articles of incorporation certified by the Secretary of State shall be received in all the courts of this State and other places, as prima facie evidence of the facts contained therein and of the due incorporation of such association.

Section 9. Amendments to Articles of Incorporation.—The Articles of Incorporation may be altered or amended at any regular meeting or any special meeting called for the purpose. An amendment must first be approved by two-thirds of the directors and then adopted by a vote representing two-thirds of all the members of the association. Thereupon the association shall make under its corporate seal and the hands of its president or vice-presdent and secretary or assistant secretary, a certificate accordingly, and the president or vice-president shall duly execute and acknowledge such certificate before an officer authorized by law to take and certify acknowledgments of deeds, and such certificate so executed and acknowledged shall be filed in the office of the Secretary of State; and upon so filing the same, the articles of incorporation of such association shall be deemed to be amended accordingly; provided, however, a fee of only five dollars ($5.00) shall be required therefor by the Secretary of State.

Section 10. By-Laws.—Each association incorporated under this Act shall adopt for its government and management, a code of by-laws not inconsistent with the powers granted by this Act. A majority vote of the members or stockholders or their written assent, is necessary to adopt such by-laws. The by-laws may be altered or amended in the manner provided for therein. Each association, under its by-laws, may provide for any or all of the following matters:

(a) The time, place, and manner of calling and conducting its meetings, which meetings and meetings of its directors, may be held either within or without the State.

(b) The number of stockholders or members constituting a quorum.

(c) The right of members or stockholders to vote by proxy or by mail or both; and the conditions, manner, form and effects of such votes.

(d) The number of directors constituting a quorum.

(e) The qualifications, compensation and duties and term of office of directors and officers; time of their election and the mode and manner of giving notice thereof.

(f) Penalties for violations of the by-laws.

(g) The amount of entrance, organization and membership fees, if any; the manner and method of collection of the same; and the purposes for which they may be used.

(h) The amount which each member or stockholder shall be required to pay annually or from time to time, if at all, to carry on the business of the association; the charge, if any, to be paid by each member or stockholder for services rendered by the association to him and the time of payment and the manner of collection; and the form of marketing contract between the association and its members or stockholders, which marketing contract shall be binding upon every member or stockholder, unless otherwise agreed upon in writing.

(1) The number and qualification of members or stockholders of the association and the conditions precedent to membership or ownership of common stock; the method, time, and manner of permitting members to withdraw or the holders of common stock to transfer their stock; the manner of assignment and transfer of the interest of members and of the shares of common stock; the conditions upon which and time when membership of any member shall cease; the automatic suspension of the rights of a member when he ceases to be eligible to membership in the association; the mode, manner, and effect of the expulsion of a member; whether a member upon withdrawal, death or expulsion shall have any interest in the property of the association, if organized without capital stock; the manner of determining the value of the property interest or the shares of common stock of retiring or expelled members, which interest or stock may be conclusively appraised by the board

of directors of the association and purchased by the association at such value within one year after the date of such retirement or expulsion.

Section 11. General and Special Meetings; How Called.—In its by-laws each association shall provide for one or more regular meetings annually. The board of directors shall have the right to call a special meeting at any time, and ten per cent of the members or stockholders may file a petition stating the specific business to be brought before the association and demand a special meeting at any time. Such meeting must thereupon be called by the directors. Notice of all special meetings, together with a statement of the purpose thereof, shall be mailed to each member at least ten days prior to the meeting; provided, however, that the by-laws may require instead that such notice may be given by publication in a newspaper of general circulation, published at the principal place of business of the association.

Section 12. Directors; Election.—

(a) The affairs of the association shall be managed by a board of not less than three directors, to be elected by the members or stockholders, with such qualifications as may be provided for in the articles of incorporation or the by-laws. The by-laws may provide that the territory in which the association has members shall be divided into districts and that the directors shall be nominated according to such district, either directly or by district delegates elected by the members in that district. In such case the by-laws shall specify the number of directors to be nominated by each district, the manner and method of reapportioning the directors and of redistricting the territory covered by the association. The by-laws may provide that primary elections shall be held in each district to nominate the directors apportioned to such districts and the result of all such primary elections may be ratified by the next regular meeting of the association or may be considered final as to the association. The by-laws may provide that one or more directors may be nominated by the Commissioner of Agriculture or by the other directors nominated by the members or their delegates. Such directors shall represent primarily the interest of the general public in such associations. Such directors shall not number more than one-third of the entire number of directors.

(b) An association may provide a fair remuneration for the time actually spent by its officers and directors in the service and for the service of the members of its executive committee. No director, during the term of his office, shall be a party to a contract for profit with the association differing in any way from the business relations accorded regular members or holders of common stock of the association or others, or differing from terms generally current in that district.

(c) The by-laws may provide for an executive committee to be elected by the board of directors from within or without the membership of the board and may allot to such committee all the functions and powers of the board of directors, subject to the general direction and control of the board.

(d) When a vacancy on the board of directors occurs other than by expiration of term, the remaining members of the board, by a majority vote, shall fill the vacancy, unless the by-laws provide for the nomination of directors by districts. In such case the board of directors shall call a special meeting of the members or stockholders in the respective district to nominate a person qualified to fill the vacancy.

Section 13. Election of Officers.—The directors shall elect from their number a president and one or more vice-presidents. They shall also elect a secretary, a treasurer, and such other officers as may be provided for in the by-laws, none of whom need be directors or members of the association. The office of secretary and treasurer may be combined into one office designated as secretary-treasurer, or both functions and titles may be united in one person. The treasurer may be a bank or any depository, and as such, shall not be considered as an officer, and as a function of the board of directors, and in such case the secretary shall perform the usual accounting duties of the treasurer excepting that the funds shall be deposited only as and where authorized by the board of directors.

Section 14. Stock—Membership Certificate—When Issued—Voting—Liability—Limitation on Transfer and Ownership.—When a member of an association organized without capital stock has paid his membership fee in full he shall receive a certificate of membership. An association may issue its shares of stock having no par value from time to time for such consideration as may be fixed by the board of directors. No association shall issue stock until it has been fully paid for. Promissory notes may be accepted by the association as full or partial payment for such stock. The association shall hold the stock as security for the payment of the note; but such retention as security shall not affect the right of any stockholder to vote unless such notes are past due.

No member shall be liable for the debts of the association to an amount exceeding the sum remaining unpaid on his membership fee or his subscription to capital stock, including any unpaid balance on any promissory notes given in payment thereof.

No stockholder of an association organized hereunder, except an association organized under this Act or an association as defined in this Act, shall own more than one-third of the outstanding common stock of the association; and an association in its by-laws may limit the amount of common stock which one member may own to an amount less than one-third of the outstanding common stock. The association shall limit its dividends on stock, both common and preferred, to any amount not greater than eight (8%) percentum per annum on the par value thereof, or if such capital stock is without par value, then upon the actual cash value of the consideration received by the association therefor. The association by the vote of its directors, may establish and accumulate reserves out of earnings, including a permanent surplus fund as an addition to capital. Net income in excess of additions to reserves and surpluses so established, shall be distributed to the members of the association on the basis of patronage. Any distribution of reserves and surpluses at any time shall be made to members at the time such distribution is ordered on the basis of patronage.

Any receipts or dividends from subsidiary corporations or from stock or other securities owned by the association shall be included in the ordinary receipts of the association.

No member in any association without capital stock shall be entitled to more than one vote; but the by-laws may provide that such members or the holders of common stock in an association with capital stock, may vote upon any or all questions on a patronage basis.

Preferred stock may be sold to any person, member or non-member, and may be redeemable or retireable by the association on such terms and conditions as may be provided for in the article of incorporation, and printed on the stock certificates. The by-laws, except as otherwise provided for in this Act, shall prohibit the transfer of common stock of the association to persons not engaged in the production of agricultural products and such restrictions shall be printed upon every certificate of stock subject thereto.

Section 15. Removal of Officer or Director.—Any member may bring charges against an officer or director by filing them in writing with the secretary of the association, together with a petition signed by ten per cent of the members, requesting the removal of the officer or director in question. The removal shall be voted upon at the next regular or special meeting of the association, and by a vote of a majority of the members, the association may remove the officer or director and fill the vacancy. The director or officer against whom such charges have been brought shall be informed in writing of the charges previous to the meeting and shall have an opportunity at the meeting to be heard in person or by counsel and to present witnesses; and the person or persons bringing the charges against him shall have the same opportunity.

In case the by-laws provide for election of directors by districts with primary elections in each district then the petition for removal of a director must be signed by twenty per cent of the members residing in the district from which he was elected. The board of directors must call a special meeting of the members residing in that district to consider the removal of the director. By a vote of the majority of the members of that district the director in question shall be removed from office.

Section 16. Referendum.—Upon demand of one-third of the entire board of directors made immediately and so recorded at the same meeting at which the original motion was passed any matter that has been approved or passed by the board must be referred to the entire membership or the stockholders for decision at the next special or regular meeting; provided, however, that a special meeting may be called for the purpose.

Section 17. Marketing Contract.—The association and its members may make and execute marketing contracts requiring the members to sell, for any period of time, all or any specified part of their agricultural products or specified commodities exclusively to or through the association or any agencies designated by the association. The contracts may provide that the association may sell or resell the products of its members with or without taking title thereto; and pay to its members the resale price, after deducting all necessary selling, overhead and other costs and expenses, including interest or dividends on stock, not exceeding eight per cent per annum, and reserves for retiring the stock, if any; and other proper reserves; and any other proper deductions.

Section 18. Remedies for Breach of Contract.—

(a) The by-laws and the marketing contract may fix, as liquidated damages, specific sums to be paid by the member or stockholder of the association upon the breach by him of any provisions of the marketing contract regarding the sale or delivery or withholding of products; and may further provide that the member will pay all costs, premiums for bonds, expenses and fees in case any action is brought upon the contract by the association; and any such provisions shall be valid and enforceable in the courts of this State.

(b) In the event of any such breach or threatened breach of such marketing contract by a member, the association shall be entitled to an injunction to prevent the further breach of the contract and to a decree of specific performance thereof. Pending the adjudication of such an action and upon filing a verified complaint showing the breach or threatened breach, and upon filing a sufficient bond, the association shall be entitled to a temporary restraining order and preliminary injunction against the member.

Section 19. Conflicting Laws Not to Apply.—Any provisions of law which are in conflict with this Act shall not be construed as applying to the association herein provided for.

Section 20. Limitations of Use of Term "Cooperative".—No person, firm, corporation or association, hereafter organized or doing business in this State, shall be entitled to use the word "cooperative" as part of its corporate or other business name or title unless it has complied with the provisions of this Act.

Any person, firm, corporation or association now organized and existing or doing business in this State, and embodying the word "cooperative" as part of its corporate or other business name or title, and which is not organized in compliance with the provisions of this Act, shall within six months from the date at which this Act goes into effect, eliminate the word "cooperative" from its said corporate or other business name or title.

Section 21. Interest in Other Corporations or Associations.—An association may organize, form, operate, own, control, have an interest in, own stock of, or be a member of any other association or corporation, with or without capital stock, and engaged in planting, growing, producing, preserving, drying, processing, canning, packing, storing, warehousing, handling, shipping, utilizing, manufacturing or selling of agricultural products or by-products thereof; or in performing business or educational services; or in the financing of any of the above enumerated activities.

If such corporations are warehousing corporations, they may issue legal warehouse receipts to the associations against the commodities delivered by it, or to any other person and such legal warehouse receipts shall be considered as adequate collateral to the extent of the usual and current value of the commodity represented thereby. In case such warehouse is licensed, or licensed and bonded under the laws of this or any other state or the United States, its warehouse receipt delivered to the association on commodities of the association or its members, or delivered by the association or its members, shall not be challenged or discriminated against because of ownership or control wholly or in part, by the association.

Section 22. Contracts and Agreements with Other Associations.—Any association may, upon resolution adopted by its board of directors, enter into all necessary and proper contracts and agreements and make all necessary and proper stipulations, agreements and contracts, and arrangements with any other cooperative corporation, association or associations, formed in this or in any other State, for the cooperative and more economical carrying on of its business or any part or parts thereof. Any two or more associations may, by agreements between them, unite in employing and using or may separately employ and use the same personnel, methods, means, and agencies for carrying on and conducting their respective businesses.

Section 23. Associations Heretofore Organized May Adopt the Provisions of This Act.—Any corporation or association organized under previously existing statutes, may, by a majority vote of its stockholders or members, be brought under the provisions of this Act by limiting its membership and adopting the other restrictions as provided herein. It shall make out in duplicate a statement signed and sworn to by its directors to the effect that the corporation or association has, by a majority vote of its stockholders or members, decided to accept the benefits and be bound by the provisions of this Act and has authorized all changes accordingly. Articles of incorporation shall be filed as required in section 9 of this Act, except that they shall be signed by the members of the then board of directors. The filing fee shall be the same as for filing an amendment to articles of incorporation.

Section 24. Associations not in Restraint of Trade.—No association as defined in this Act while engaged in any of the activities specified herein shall be deemed to be a conspiracy, or a combination in unlawful restraint of trade, or an illegal monopoly, or an atempt to lessen competition or to fix prices arbitrarily; nor shall the marketing contracts and agreements between the association and its members, or any agreements authorized in this Act, be considered illegal as such, or in unlawful restraint of trade, or part of a conspiracy or combination to accomplish an improper or illegal purpose.

Section 25. Rights and Remedies Apply to Similar Associations of Other States.—Any cooperative association with or without capital stock as defined in this Act heretofore or hereafter organized under the laws of another state shall be allowed to carry on any proper activities, operations and functions in this State upon the filing with the Secretary of State of a certified copy of its articles of incorporation and the payment of a filing fee of Ten Dollars ($10.00) in lieu of all franchise or license or corporation taxes as required of associations organized hereunder, and all contracts which could be made by any association organized hereunder, made by or with such associations shall be legal and valid and enforceable in this state with all of the remedies set forth in this Act.

Section 26. Quo Warranto to Test Validity of Incorporation.—The right of an association claiming to be organized and incorporated and carrying on its business under this Act to do and to continue its business, may be inquired into by quo warranto at the suit of the Attorney-General, but not otherwise.

Section 27. Dissolution.—Any association incorporated under or adopting the provisions of this Act may be dissolved and its affairs wound up voluntarily by a petition signed by two-thirds of the members or by the holders of two-thirds of the common stock, either in person or by their agent, which petition shall be presented to the Circuit Judge, who shall direct notice thereof to be published for such time as he may judge expedient. After the expiration of the time of such notice, the Circuit Judge may decree a dissolution and make all necessary orders and decrees for the winding up of its affairs, including the application of its assets toward the satisfaction of the claims of creditors so far as may be and the distribution of any moneys then remaining among its members in proportion to their respective property interests.

Any such association shall continue to be a body corporate for a term of two years after the date of the degree or dissolution for the purpose of prosecuting and defending suits and settling its affairs, and the president and directors at the time of its dissolution, and the survivors of them, or such other person or persons as may be appointed by the Circuit Judge, shall be trustees of such association for that purpose during said term with full power in its name to settle its affairs, collect all sums due it, sell and convey its property, pay its debts as far as may be, and distribute any moneys or property then remaining among those entitled thereto.

Section 28. Constitutionality.—If any section of this Act shall be declared unconstitutional for any reason, the remainder of this Act shall not be affected thereby.

Section 29. Application of General Corporation Laws.—The provisions of the laws of this State with respect to corporations for profit and all powers and rights thereunder shall apply to associations organized hereunder, except where such provisions are in conflict with or inconsistent with the express provisions of this Act.

Section 30. Repeals. Laws Affected.—All laws or parts of laws in conflict with the provisions of this Act are hereby repealed: Provided, however, that the provisions of this Act shall not be construed to affect, limit or in any wise interfere with the rights, powers, or privileges of any corporation or association which may have been organized and which now exists, or of any corporation or association which may be hereafter organized under Chapter 5958 of the Acts of 1909 and amendments thereto.

Section 31. This Act shall take effect immediately upon its passage and approved by the Governor or upon its becoming a law without such approval.

Approved June 10, 1931.

Bulletin 250 June, 1932

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UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
GAINESVILLE, FLORIDA
Wilmon Newell, Director

In Cooperation with Bureau of Entomology, United States Department of Agriculture, and State Plant Board of Florida.

SOME MAJOR CELERY INSECTS IN FLORIDA

By

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*In cooperation with U.S.D.A.

SOME MAJOR CELERY INSECTS IN FLORIDA

By E. D. BALL, B. L. BOYDEN and W. E. STONE

A complete enumeration of the insects that are occasionally injurious to celery in the fields would include a score or more, but for practical purposes the discussion may be limited to five forms: Celery leaf-tier*, celery looper**, cutworms***, semitropical army worm†, and red spider††. (This latter pest is not, strictly speaking, an insect.)

Cutworms are easily recognized by their greasy and thickset bodies, as well as by their habit of feeding at the base of or in the heart of the plant. The semitropical army worm in its younger larval stage is very variable in color but almost always can be distinguished by a definite hump with shining black markings situated on the upper side and about one-third of the way back from the head. As these larvae increase in size they take on definite yellow stripes. These larvae usually appear on the small plants in the fall and rapidly destroy them. The celery leaf-tier and the celery looper are both inconspicuous green larvae that appear later in the season. The celery looper is the larger and of a definite green color. It feeds very largely on the outer and upper green leaves and has a habit of dropping to the ground when disturbed. It can always be distinguished by its looping method of travel.

THE CELERY LEAF-TIER

The first carload of celery was shipped from the Sanford area in 1899 and the industry developed rather slowly but steadily until 1920, at which time 2,000 cars were shipped. Since 1920 it has rapidly increased to a maximum of about 6,000 cars per year. During the greater part of this time insect pests were scarcely a factor in the production of the crop.

Celery leaf-tier larvae had been observed but had not been of economic importance until the season of 1922-23, when they appeared in large numbers and did considerable damage. In 1923-24 they were still injurious but not as much so as in the previous year. In 1924-25 they invaded the fields in alarming numbers, causing considerable damage. As a result of the three successive

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***Phlyctaenia rubigalis* Guenee.

***Autographa falcifera* Kirby.

***Noctuidae, several species.

†*Xylomyges eridania* Cramer.

††*Tetranychus telarius* Linn.

seasons' damage, the celery industry was in a demoralized condition and the future looked doubtful. During 1924-25 several forms of arsenic were used to destroy the larvae, with disastrous results, as the great amount of arsenical residue on the celery rendered it unsalable. Expensive washing equipment afforded partial relief but the whole situation was unsatisfactory. At this time help was sought and investigations were started cooperatively by the Florida State Plant Board, the Florida Agricultural Experiment Station and the Bureau of Entomology of the United States Department of Agriculture. Since that time five more celery seasons have passed, three in which no damage has occurred, and two, the seasons of 1926-27 and 1928-29, in which the damage would have been excessive if control measures had not been almost universally applied.

The development of efficient control methods meets the immediate need of the grower but an understanding of the factors that brought about the ruinous outbreak of this pest may easily be of more value in determining whether such outbreaks are to be expected in the future or whether the industry may look forward to comparative immunity from this pest, except as the result of the culmination of climatic cycles. To test this latter possibility, an intensive study was made of the factors that contribute toward the normal natural control of this pest.

WINTER TEMPERATURES

The mean temperature of each season from the beginning of these outbreaks to the present time has been plotted in Fig. 1 A and B, in which the heavy black lines represent the normal temperature. In the years during which the celery leaf-tier caused damage (Fig. 1 A) the mean temperature of the four vital months of the crop season, December to March, is shown to be above normal with the exception of December of the season 1928-29 and January and March of the season of 1926-27. The high temperatures of the other months of the seasons entirely offset any inhibiting effect low temperatures of the shorter periods of cold weather might have had. In the years (Fig. 1 B) when the temperature of the four vital months was above the normal mean only in December and January of the season of 1923-24 and January and February of the season 1929-30 and only slightly above in February and March of the season of 1927-28, there was only one case of damage and it was not severe. The abnormally high temperature during December, 1923, enabled the celery leaf-tier

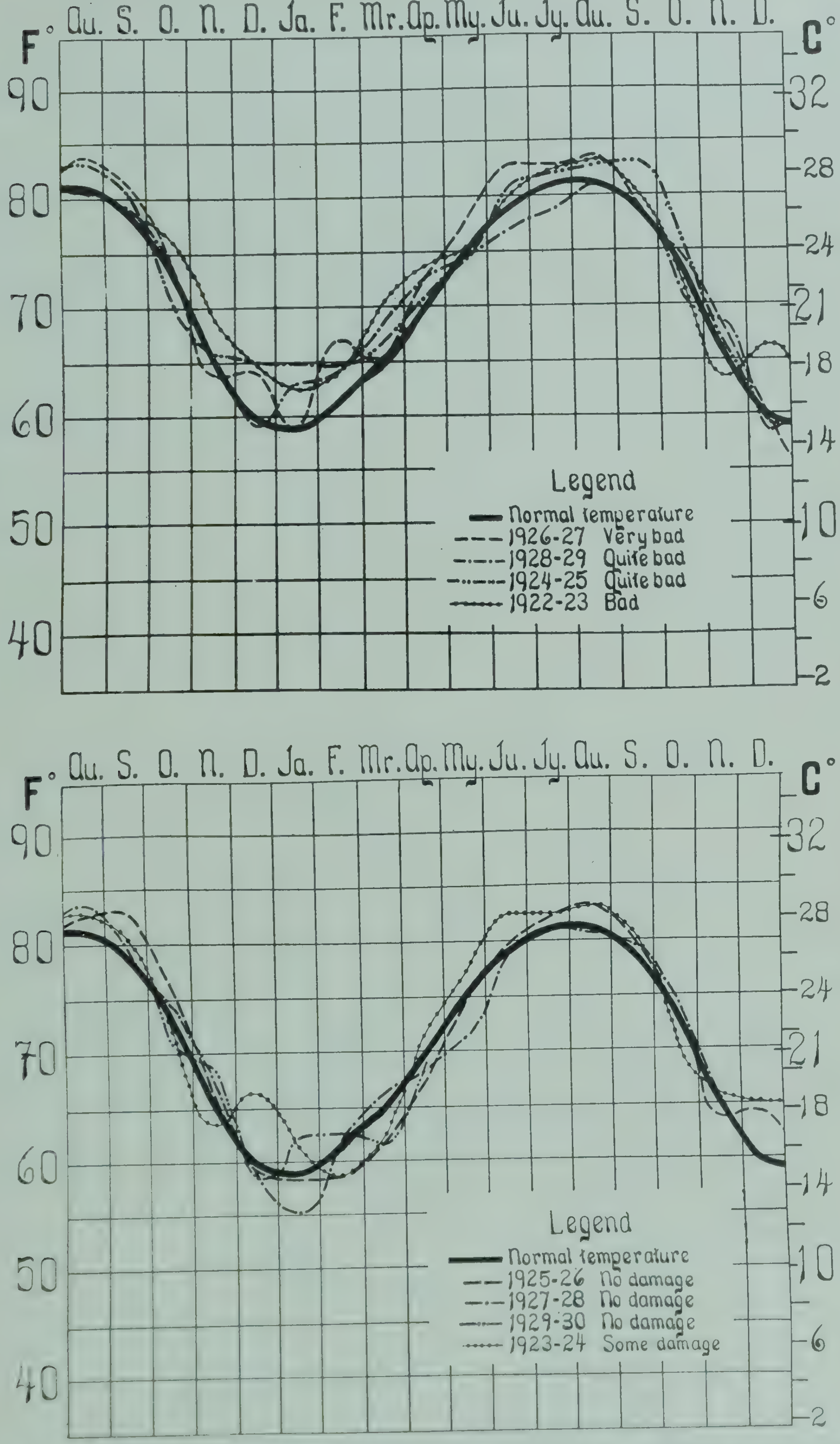

FIG. 1.—Mean monthly temperatures of seasons with varying amounts of injury from the celery leaf-tier. A (above), Warm years in which severe damage occurred. B (below), Cold years, in three of which no damage occurred; there was slight damage in the fourth.

to develop at a rate much higher than the normal and some injury resulted in the early celery. However, the colder temperatures of the succeeding months took care of the situation. The cold temperatures during February and March, the two most critical months in determining the severity of infestation, may easily be seen. Taking this as a guide, the mean temperatures of December, January, February and March of each year since 1891 has been averaged and plotted in Fig. 2. It will be seen from this diagram that the winter temperatures beginning with 1891 were almost steadily falling from that time until 1902, and that from 1902 until the present time (1929-30) they have been slowly but steadily rising, culminating in five of the eight warmest winters in the last 30 years. These were the five winters in which the celery leaf-tier damage was excessive.

During all of the generally cold winters from 1895 to 1910 no celery leaf-tier damage was known, and even in the three recent winters, 1925-26, 1927-28 and 1929-30, in which the mean temperature was close to the normal, the celery leaf-tier caused no injury, indicating very definitely that a high winter temperature

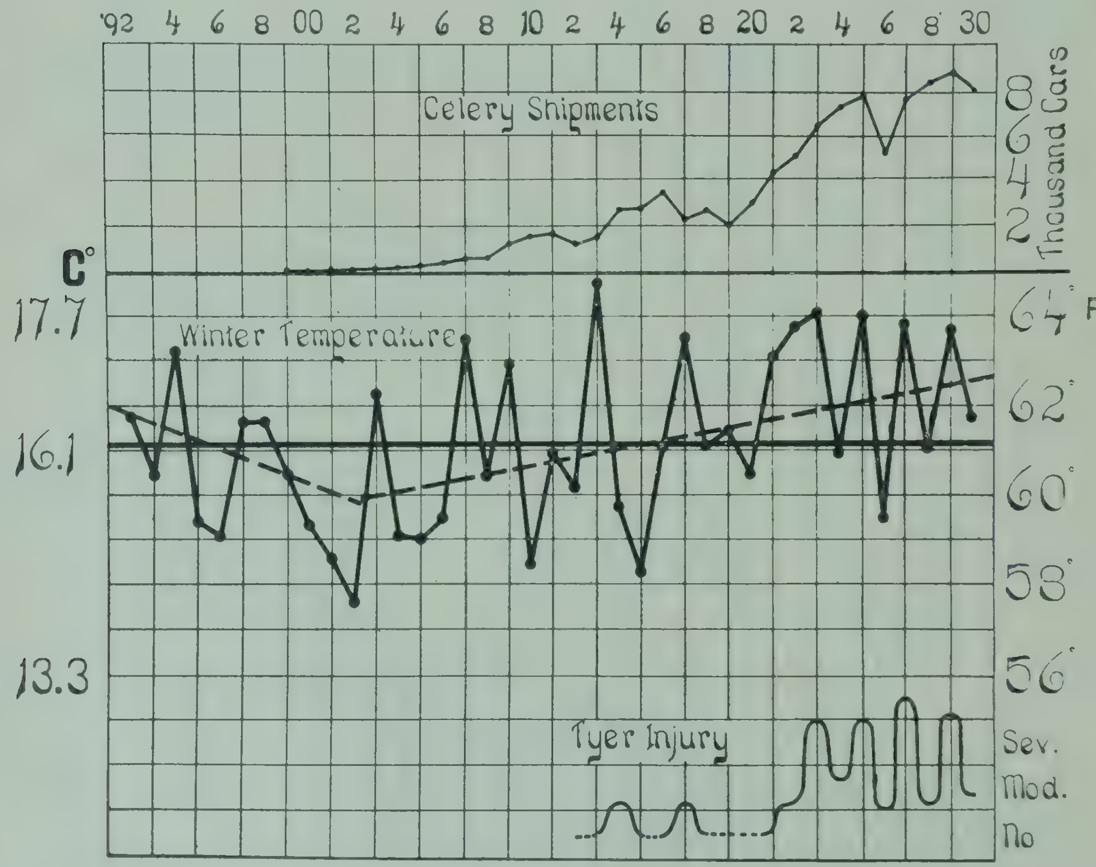

FIG. 2.—The mean winter temperatures (December-March) of Florida, 1891 to 1930. Celery shipments and leaf-tier injury for the later years are shown.

is at least one of the essential factors in the development of celery leaf-tier damage. The older celery growers tell of two periods previous to the recent outbreak in which the celery leaf-tier "worms" became numerous enough to pile up under the conveyor belts. These two periods (1904 and 1907) are plotted beneath the temperature scale and it will be noted (Fig. 2) that they occurred when one mild winter followed another, thus indicating that it takes two warm winters in succession to bring the celery leaf-tier up to sufficient numbers to begin to be injurious, then after that succeeding warm winters will be injurious ones. The most recent outbreak also was preceded by two warm winters in which no injury occurred. It seems probable, therefore, that after a series of cold winters in which the celery leaf-tier is reduced to a minimum at least two warm winters in succession are required before the pest reaches the injurious stage, then any succeeding warm winters will show injury. The writers have obtained the records

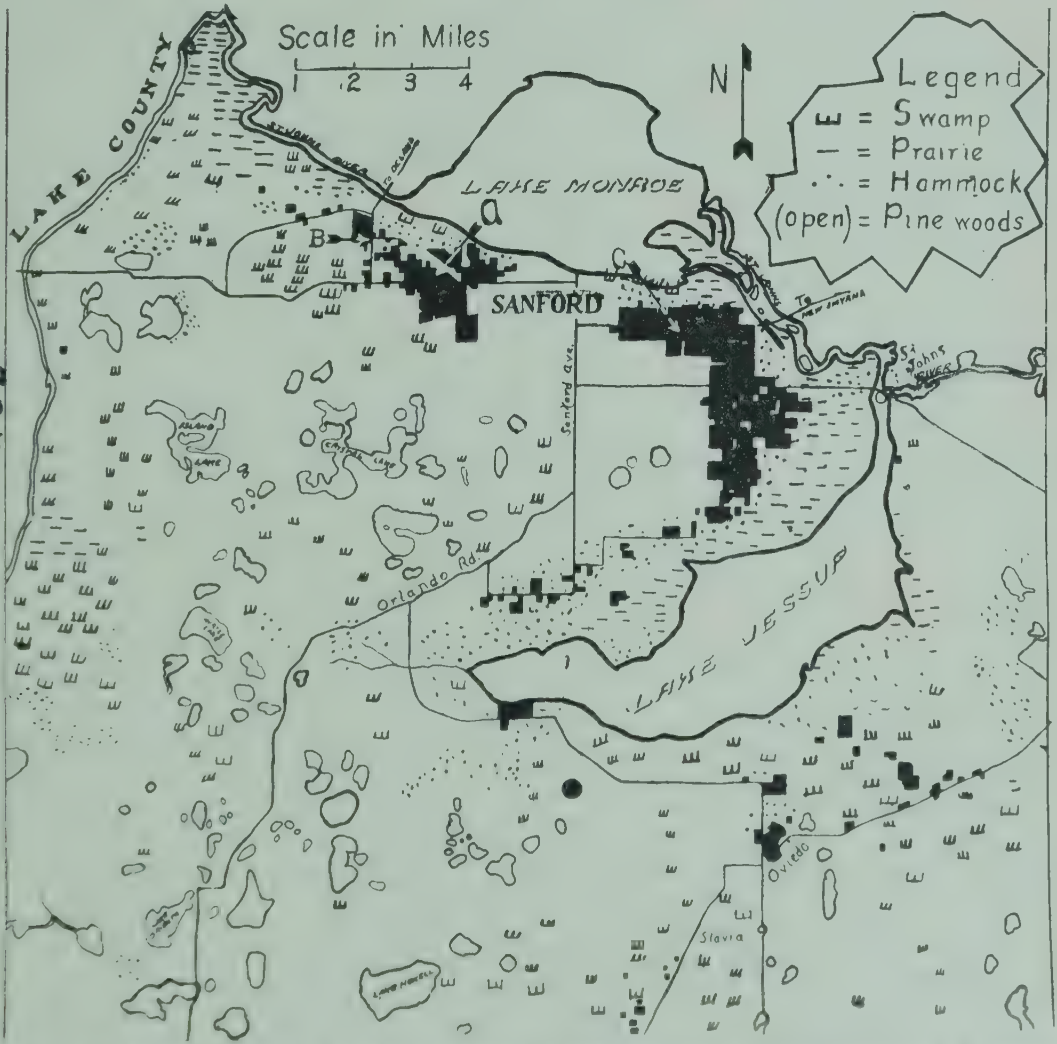

Fig. 3.—Map of the Sanford celery area, showing distribution of celery plantings and location of thermometers (indicated by Stations A, B and C, near Lake Monroe).

of winter temperatures in Florida from 1739 to date, with the exception of 60 years between 1760 and 1820. This gives 130 years' record of winter temperatures and during this period there were only six cycles of warm winters comparable to the present cycle. From a study of records it is evident that the cycle of warm winters just experienced is not a normal condition and with its disappearance will probably go the major danger from the celery leaf-tier.

RELATIVE TEMPERATURES AT SANFORD

The distribution of celery plantings in the Sanford area is shown in Fig. 3. From this map it will be observed that there is a solid block to the southeast of the city, a small solid block to the west, and a still smaller area in the Lake Monroe region, with scattered plantings around the margins of Lake Jessup, including those at Oviedo.

In the study of the distribution of the celery leaf-tier injury it was soon discovered that the area of worst infestation occurred in a strip only a mile or two wide extending obliquely northwest-southeast from the widest place in Lake Monroe towards Lake Jessup and that a secondary area of slightly less infestation occurred in that area on the west side still within the influence of the winds blowing across Lake Monroe from the northwest, while as one moved westward towards the Lake Monroe railway station the injury became less and less until it was of no commercial importance beyond the tempering effect of the lake. The solid block of fields to the south of Lake Monroe station has never experienced serious injury. In making these observations it was also noted that the injury of the celery leaf-tier was almost inversely proportional to the injury from frost in the different regions, again suggesting that it was the warming influence of Lake Monroe on the northwest winds that made conditions more favorable for the development of the celery leaf-tier. In studying the winter temperatures it was found that a variation of only 2 degrees in the mean winter temperature of a season would make all the difference between a serious outbreak and no commercial injury. Recording thermometers were used on the west side beyond the area of commercial damage by the celery leaf-tier and another set in the strip on the east side where injury was at the maximum (Fig. 3 B and C). These thermometers showed an almost constant difference in the average minimum temperatures during the winter period of approximately 2 degrees (Fig. 4).

again indicating the close response of this insect to variations in winter temperature.

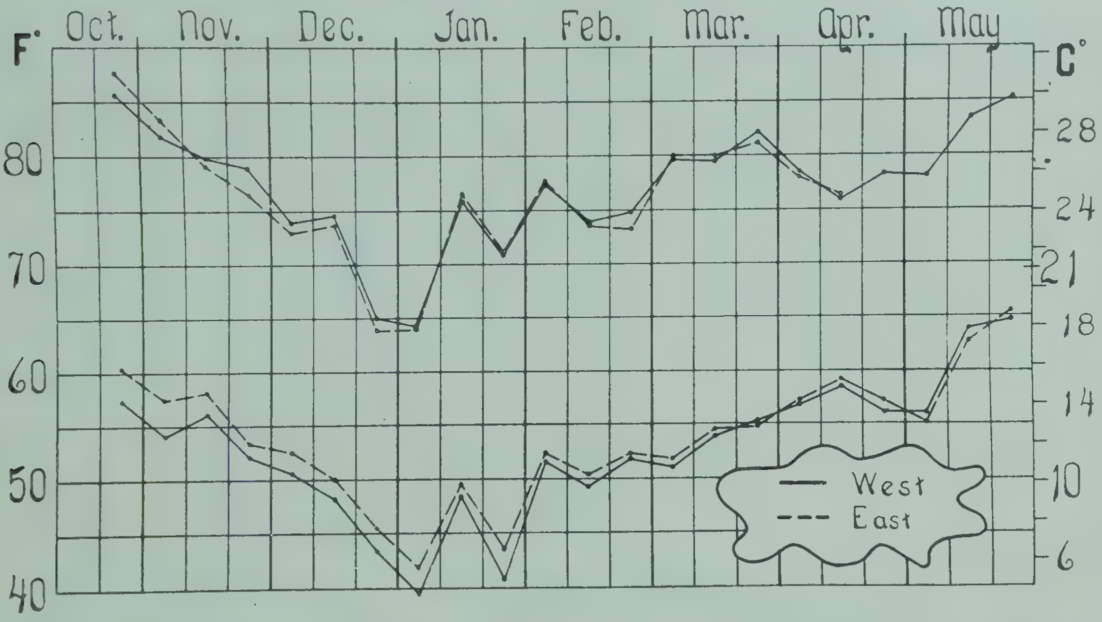

FIG. 4.—Average maxima and minima (temperatures) of the west side (Station B) and the east side (Station C) of the Sanford celery area, plotted by 10-day periods.

OTHER FACTORS IN NATURAL CONTROL

Temperature is always a very important factor in the celery leaf-tier's development but there are two other factors that are almost equally as important in controlling the celery leaf-tier in abnormal winter seasons, namely, egg parasites and birds. Temperatures may be predicted in advance in certain cases but they cannot be controlled, while on the other hand conditions favorable to the activity of the other two factors are largely within the control of the growers. It is therefore important that the conditions which favor their operation be understood.

THE EGG PARASITE

All insects have parasites, predators or diseases that tend to prevent their rapid multiplication and the celery leaf-tier is no exception. In the Sanford region it has three parasites, as well as predators and diseases, that help to keep it in check. By far the most important of these and in many cases the most important single factor in its control is a tiny black wasp (*Trichogramma minutum* Riley) that lays its eggs in the eggs of the celery leaf-tier and its larvae destroy them. This wasp is not active during the cold weather of the normal winter period, as it goes into hibernation for several months. It becomes active again a short time before the celery leaf-tier disappears in the spring. It then breeds all summer on various other species of leaf-tiers that live on the careless weeds (*Amaranthus* spp.) in the fields and usually becomes abundant in the fall at about the time the fields are being plowed up and the careless weeds destroyed. At this time as high as 160 little wasps have been hatched out of 100 eggs of related leaf-tiers on the careless weeds.

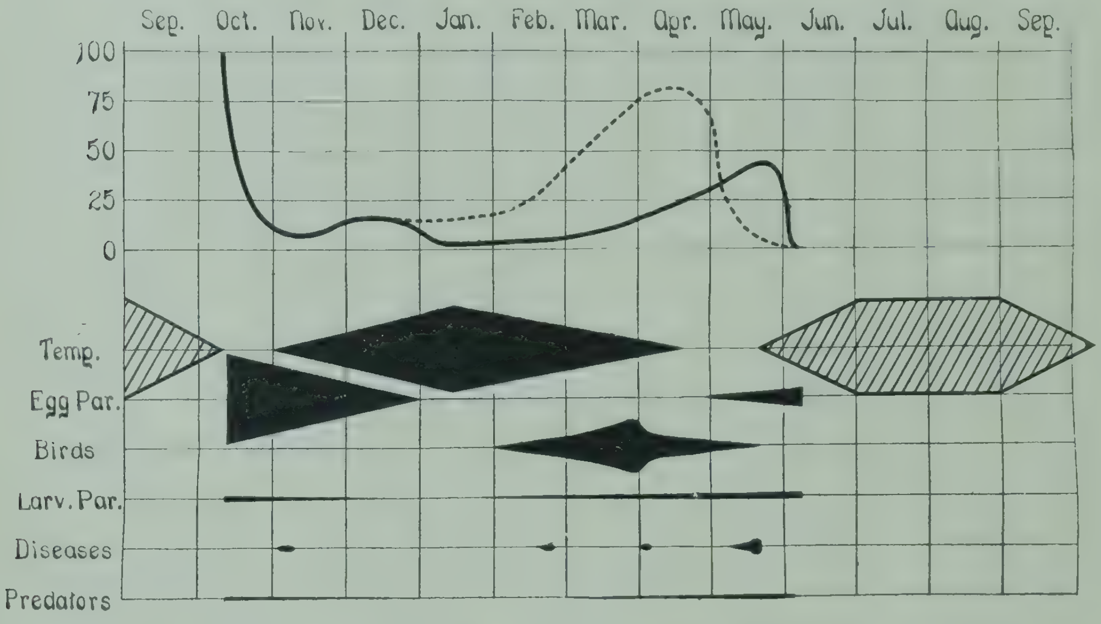

FIG. 5.—The balance of nature — The relative importance and period of activity of the various factors concerned in the normal natural control of the celery leaf-tier.

——————— Infestation during normal year.

. . . . Infestation during abnormal year when balance of nature is disturbed.

Width and length of black markings show relative importance of factors.

Cross-hatching shows when high temperatures become operative in inhibiting population of celery leaf-tier.

These little wasps are therefore swarming in early October at the time the celery leaf-tier normally appears in the fall and, with their other hosts gone, they are immediately attracted to the celery leaf-tier eggs and destroy them nearly as fast as they are laid. This good work is kept up until the temperature falls to a point where they cease to be active, as shown in Fig. 5. As the temperature continues to fall it materially slows down the activity of the celery leaf-tier and this continues throughout the winter period. As the temperatures increase in the spring, however, the celery leaf-tier becomes more active and would become seriously injurious if it were not for the third factor, birds.

THE MIGRATORY BIRDS

As the migratory birds come through in the spring of the year and the birds that have been wintering in Florida find the food in the woods becoming scarce they enter the celery fields and commence to feed on the larvae, pupae and moths of the celery looper and the celery leaf-tier.

The first bird to appear in numbers is usually the little palm warbler. These birds perch in the tops of the celery or run up and down between the rows picking off the larvae and pupae. Oftentimes they will be seen perching in numbers on the crates back of a harvesting crew and snapping up every moth that flies out of the celery.

A little later the swallows appear. They usually spend their time over the swamps picking up the gnats and mosquitoes, but as soon as the sprayer or duster appears in the celery fields and begins to disturb the moths the swallows appear and commence to snap them up. With the beginning of pyrethrum dusting the swallows become more important. The pyrethrum is apparently disagreeable to the moths and they continually dart up into the air in short flights, only to drop back into the celery again. This is continued until they finally escape from the dusted area. The swallows, following the dusters and skimming over the celery after it has been dusted, pick up many moths that appear above the surface of the celery. When conditions are favorable the swallows continue this work for a day or two, or until the moths are practically eliminated from the field.

Later in the season, after the warblers have gone north and most of the swallows have disappeared, the mocking birds, meadowlarks, grackles and blackbirds that are nesting in the region commence to forage in the celery for the larvae with which to feed their young. A constant stream of these birds may be seen going back and forth, flying in an air line from the celery field to their nests, their bills overflowing with the larvae of the celery leaf-tier.

In a normal season the birds are plentiful enough to keep the celery leaf-tier entirely under control in the isolated fields and those adjoining woodlands. In the solidly planted areas where there is little shrubbery to afford the birds protection they appear in smaller numbers and if the infestation is very great there will not be birds enough to take care of it. Much could be done to encourage the birds by the planting of small, shrubby trees like the haw or the wild plum along the ditch banks in the solidly planted areas. It might even be possible to set aside small strips a mile or so apart as bird refuges.

SEASONAL INCIDENCE OF THE CELERY LEAF-TIER

In an average season the celery leaf-tier in the Sanford area diminishes in population in late May or early June and does not build up again until about the 10th of October, when fresh moths make their appearance in the earliest planted seedbeds. The normal temperature at the time of the apparent disappearance is between 75° and 77°F.* They appear in the fall following the first sharp drop in temperature after the mean temperature of the season has fallen to 77° or below. Sharp drops in temperature at this time almost always follow rainstorms, so that the celery leaf-tier may be expected to appear as soon as the mean temperature has fallen to 77° or below and there occurs a rain followed by a sharp drop in temperature. In an exceptionally hot and dry fall the moths may not appear until November. In an equally hot spring they may disappear early in May. One cool September a part of them came out following a storm and drop in temperature on the 10th but due to parasites and predators none of these survived to produce progeny.

DESCRIPTION OF THE CELERY LEAF-TIER

EGG

The eggs of the celery leaf-tier (Fig. 6 A) are very small, almost transparent, iridescent and scale-like. They may be deposited in groups of from 1 to 15 on the under sides of the leaves of the plant slightly overlapping each other. The eggs are very difficult to locate in the field and are rarely seen by the growers.

LARVA

When the larva or worm first emerges from the egg it is whitish in color with a black head, which color it retains until the first molt. As it feeds the larva becomes light green in color with a black head and later develops a pair of longitudinal white stripes on the back (Fig. 6 B). The mature larva is about three-quarters of an inch long.

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*Since the manuscript for this paper was prepared Dr. Ralph L. Miller has announced that the celery leaf-tier continues to breed, although in greatly reduced numbers, throughout the summer months on a number of native and ornamental plants, including Spanish needle, ragweed, fleabane, dog fennel, chrysanthemum and calendula (Florida Entomologist, Vol. XV, No. 2. August, 1931).

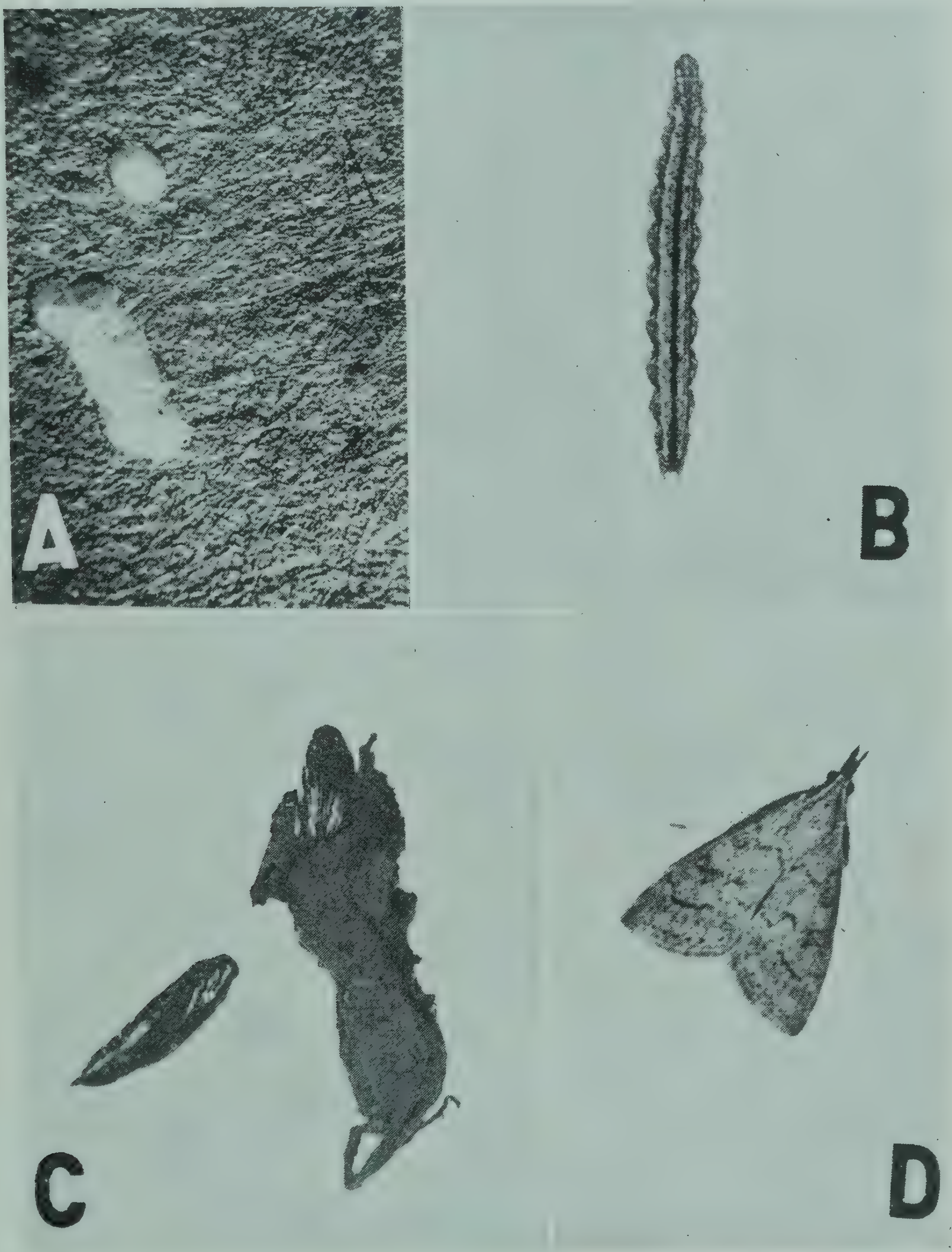

FIG. 6.—The celery leaf-tier. A, eggs; B, mature larva; C, pupae; D, adult. A, highly magnified; others magnified from 2 to 3 times. (Courtesy D. G. Kelbert.)

PUPA

The mature larva makes a cell among the leaves within which it transforms into a brown pupa measuring about three-eighths of an inch in length. As the pupa is inactive and well hidden it is rarely seen unless the cell is broken open, as shown in Fig. 6 C.

ADULT

The adult leaf-tier is a small brown moth, less than one-half inch long, with slight traces of serrated lines on the wings, giving a somewhat mottled appearance. The wings, when at rest, form a triangle (Fig. 6 D). The two most distinguishing features are the brush-like palpi in the shape of a snout and two rows of small black spots on the under side of the cream colored abdomen.

THE NUMBER OF GENERATIONS IN A SEASON ON CELERY

The planted celery is not large enough to furnish shelter for the moths that appear by the middle of October, so they seek shelter in the older seedbeds. Many of the progeny, both eggs and larvae, of these early moths will be destroyed by the parasites. Moths coming out later, after the temperature falls and the parasites have been checked, usually find favorable shelter and deposit the eggs in the fields of older celery where the plants are large enough to afford good hiding places. This generation of larvae appears late in November and throughout December (Fig. 7), and may be found in alarming numbers in a few of the older fields. Fields set later have fewer larvae and these will be younger and may not mature by the time the celery is harvested.

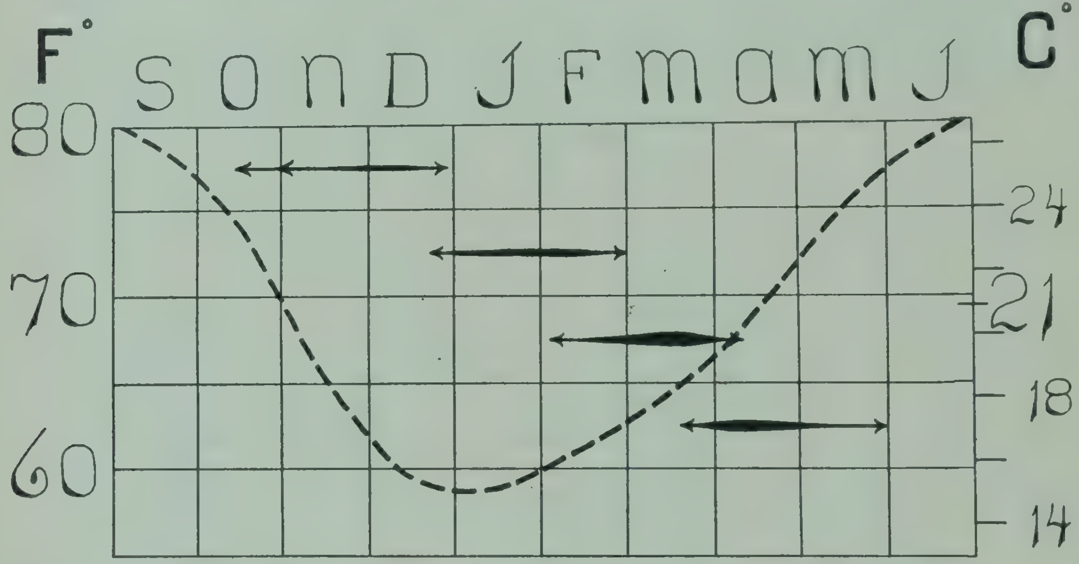

FIG. 7.—The normal life history of the celery leaf-tier in the Sanford area. The broken line represents normal temperature. The four heavy lines represent the time of appearance and relative numbers of the generations during the cooler half of a normal year. The arrow head on the line of the first generation shows where the moths which really comprise the bulk of the first generation appear, as the eggs of the moths which appear with the initial drop of temperature in the fall are practically all parasitised.

The second generation of moths appears in December and January. At about the time the celery harvest gets under way they find shelter in the other fields and deposit their eggs in celery that will be harvested within a month or six weeks. Under the temperature conditions prevailing at that time it takes nearly two months for a generation to mature, so that the majority of them are shaken off in the larval stage when the celery is harvested and consequently fail to mature. The earlier or older larvae that succeed in maturing and are thus able to survive, appear as moths to produce the third generation in February or March. If the weather is abnormally warm, as it was in 1927, this generation will do serious damage. If it is more than one degree colder than normal, as it was in 1926, the injury will hardly be noticeable.

The fourth and last generation appears in April and May and the injury caused by this generation will depend upon the numbers present and the temperature prevailing. Before the end of May the hot weather causes them to disappear rapidly.

During a normal season four generations of the celery leaf-tier may be expected. In the cold season of 1925-26, with the late start in November, only three generations developed. In an excessively warm season with an early fall start there would be four complete generations and a few of the earlier moths might lay eggs for a partial fifth generation. These larvae would, however, be harvested with the celery and take no part in the perpetuation of the species.

THE AMOUNT OF FOOD THAT A CELERY LEAF-TIER LARVA CONSUMES

The length of time required by a celery leaf-tier larva to mature varies from about 20 days to three months, depending upon the temperature. The average time in a normal season is about four weeks. The amount of food that a larva will eat is practically constant, amounting to about two and one-fourth square inches of a celery leaf, regardless of the time required for its maturity, the only difference being the rapidity with which the food is consumed. The most striking thing, however, is the relatively small amount of food consumed by a larva in the first two weeks of its life as compared with that consumed in the last four or five days, as shown in Fig. 8.

A study of this chart, in connection with the fact that the length of time the larva is feeding is dependent upon temperature, will explain a number of occurrences that would otherwise be puzzling. A fairly mature celery crop might carry 40 or 50 larvae to the stalk without any damage resulting, if it was harvested the first two or three weeks of their life. On the other hand, if this celery, which at the time was showing no damage, should be boarded about the third week of the larval growth it might easily happen that when the boards were removed 10 days later nothing would be found under the tough green leaves at the top except the bare stalks enclosing a mass of frass.

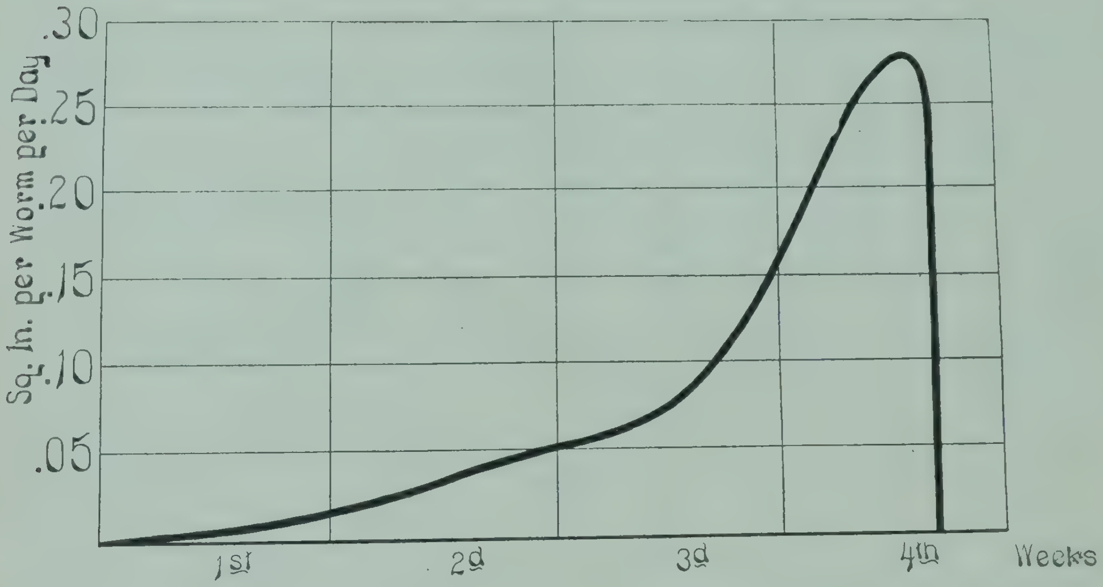

FIG. 8.—The relative feeding capacity of a celery leaf-tier larva at different ages.

SOME SUGGESTIONS ON CONTROL OF CELERY LEAF-TIER

In all economic control of injurious insects the factors of natural control, such as those shown in Fig. 5, should be kept constantly in mind and nothing done, if it can be avoided, which will seriously disturb nature's balance. The destruction of all the careless weeds in a region two or three weeks in advance of the appearance of the celery leaf-tiers might have a very disasterous effect on the egg parasites and practically eliminate them at just the period when they should be the most effective.

Birds should be encouraged to inhabit the territory surrounding celery fields. It has been observed that the swallows appear in the celery fields only during a limited period of the day. Pyrethrum dusting should be so adjusted that it will be done not only under favorable conditions for its efficiency but also under conditions in which the swallows present can work.

A full discussion of control of the celery leaf-tier, particularly artificial control, will be found in Bulletin 251 of the Florida Experiment Station.

THE CELERY LOOPER

The celery looper (or the closely related cabbage looper) is present on the celery in all sections but rarely in sufficient numbers to be injurious. As previously stated, the looper seems to prefer the green leaves of the outside canopy but occasionally attacks the inside leaves with serious results. In the Sanford area the loopers are attacked by a bacterial disease which sweeps over the fields at intervals and frequently almost elminates these larvae. This bacterial disease does not attack the eggs or the moths and the fields are soon reinfested.

In the Manatee and Sarasota districts, where the celery leaf-tier is very rare, occasional outbreaks of the looper become serious enough to warrant remedial measures. These attacks are often mistaken for outbreaks of the celery leaf-tier. Fortunately, the same treatment that is used to control the celery leaf-tier will be equally effective with the loopers.

This insect's habit of dropping to the ground when disturbed often causes unnecessary alarm, as in the handing of the crates to the washers large numbers of these loopers will work to the surface and drop off as the crates are being passed along the conveyors, occasionally resulting in a considerable accumulation of worms during the day. If the celery leaf-tier appeared in the same numbers under the conveyors it would be indicative of a rather serious outbreak, but in the case of the loopers those under the belt may represent the major portion in the area harvested and are not worthy of consideration.

CUTWORMS

Cutworms, as a group, are northern in their distribution and therefore adapted to cool temperatures. They are active during the entire celery growing season and especially so in the spring and fall. When a weedy field has been plowed and immediately prepared for celery planting it will frequently be very heavily infested by cutworms. As these larvae have been deprived of food from the time the vegetation was turned under until the celery is planted they often destroy a considerable percentage of the celery in the first few weeks and continue to injure the remainder by feeding in the heart. If such fields had been sown with poison bran mash a day or two before the celery was planted the major portion of this trouble would have been obviated. A sowing of poison bran mash at any time the cutworms are discovered doing much damage will destroy the greater number of them. The bran mash should be distributed in the evening, as the cutworms are most active and travel around at night.

If cutworms appear in the spring in celery that is more than half grown an application of the poison bran will be effective, but care should be taken that it is spread on the ground alongside the row and not dropped into the heart of the celery.

POISONED BRAN MASH

The use of poisoned bran mash is one of the most efficient methods of getting rid of certain troublesome insects before they become injurious to plants. It can be distributed on the celery fields and will eliminate the cutworms. It should be scattered around the seedbeds before they are planted.

There are many formulae for the poisoned bran mash and where any of the growers have a satisfactory method they should follow it. The following is a standard formula:

Bran	25 pounds
Paris green or white arsenic	1 pound
Syrup	½ gallon
Water	2 or 3 gallons
Oranges (or cantaloupes)	½ dozen

The bran and poison should be mixed thoroughly while dry. (One should take care not to breathe the dust from the mixture.) The syrup should be added to about two gallons of the water and then sprinkled on the bran while it is being worked so as to dampen but not wet it, water being added from time to time until the whole mass is friable. This bait should be distributed in the dusk of the evening. The oranges or cantaloupes should be chopped up fine or grated, rind, pulp and all.

SEMITROPICAL ARMY WORM

As its name implies, this insect is an inhabitant of the more tropical regions and goes into hibernation during the winter period in Florida. Its damage to the celery crop usually occurs in the fall on the early planted celery. In regions where this insect is particularly destructive a very careful watch should be kept, because within a very few days after the injury is noticed the entire crop may be destroyed, unless remedial measures are instantly applied.

These little hump-shouldered larvae, ranging all the way from black to pale yellow with black spots on the humps, spread all over the small celery and devour it rapidly. A spraying of paris green will usually serve to control it, and as the temperatures fall the danger decreases.

RED SPIDER

Red spider is a serious pest only in dry seasons. After a long dry period occurring at any time during the celery growing season, damage may be expected unless especial attention has been given to its control.

In the ordinary season the addition of one-half gallon of lime-sulphur to 100 gallons of bordeaux mixture will keep this pest under control, but in a time of drought this amount must be materially increased. In one of the worst outbreaks it was found that those who were controlling the red spider were using a gallon and a half of lime-sulphur, in many cases even more, to 100 gallons of spray mixture. Ordinarily this would be considered dangerous from the standpoint of burning, but by making the application after the heat of the day is over no damage was experienced from even the larger amounts.

THE RED SPIDER APPEARS IN ISOLATED SPOTS

The red spider appears first in little patches, oftentimes on a single plant, or two or three plants in a row. It spreads along a row rather rapidly but does not spread from row to row until the infestation is serious. As this local infestation develops the celery leaves turn white. If close watch is kept and these local

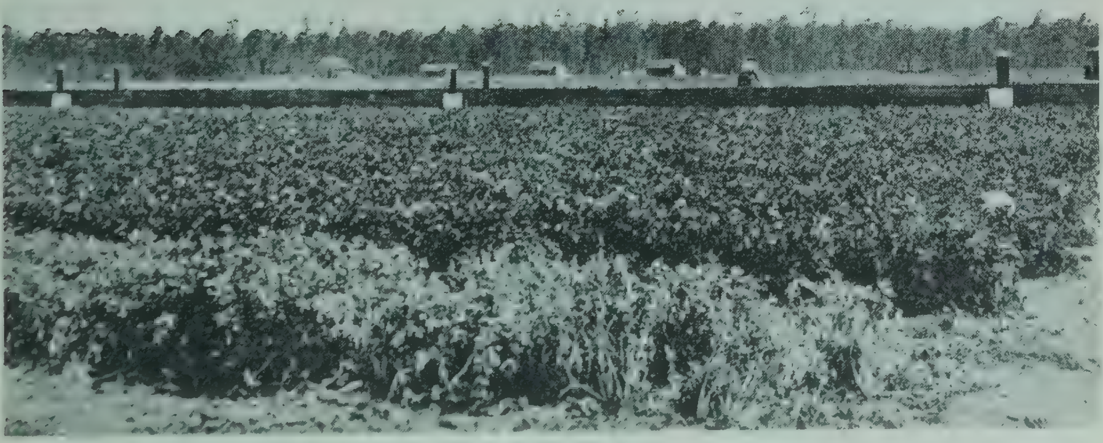

FIG. 9.—Strip of celery (foreground) abandoned on account of red spider damage. Note the whitened foliage.

infestations discovered, a heavy dusting of a mixture of one-fourth lime and three-fourths sulphur will often stop them at this point and prevent a general infestation of the fields. If, however, they are allowed to develop, the injury gradually spreads down the row and across to adjacent rows and the white patches begin to appear in the fields.

Figure 9 shows two rows of celery in the foreground badly infested by red spider. By the time the infestation reaches this stage the red spiders are climbing up to the top of the tallest leaves by the thousands and forming bright red balls. At this time they spin silken threads that float away on the breeze. Figure 10 shows these masses of red spiders and their silken webs.

If the breeze is strong enough the immature red spiders are lifted by their silken thread and distributed over the field. If the breeze is not strong enough to lift them, the threads float across to other rows of celery and the red spiders use these threads as a bridge and travel over them by the thousands to spread the infestation.

It is therefore doubly important that no heavily infested spots of this kind be allowed to remain anywhere in the celery area, as a single spot may cause an infestation over a wide area in the direction of the prevailing wind. Even if the celery is ruined, such

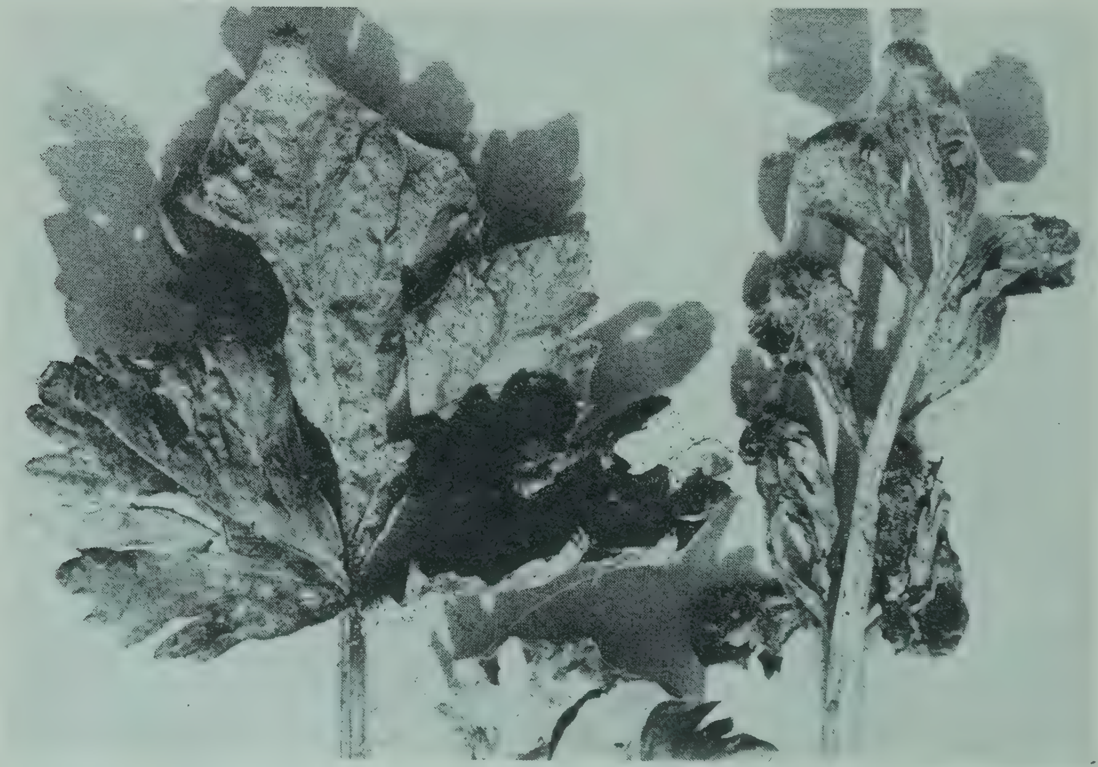

FIG. 10.—Tips of individual celery leaves showing the balling up of red spiders previous to dispersal and the webs they spin at this time.

spots should be immediately treated with heavy applications of the powdered lime and sulphur dust.

Red spider does much more damage in reducing tonnage and quality in this area than is generally realized and more attention should be paid to its control, especially in watching for and dusting the first injured spots that appear. With the present efficient dusting equipment available, it is probable that better control would be obtained in all bad infestations by using a mixture of one-fourth lime and three-fourths sulphur as a dust.

EFFICIENCY OF SOME POISONS

At the time this work was begun the writers found calcium arsenate was used almost universally, whether applied as sprays, dusts or baits. A series of careful tests were made to ascertain the relative killing efficiency of this poison as compared with paris green.

Potted plants were thoroughly dusted on both sides of the leaves with the different poisons. Cages were then placed over them and a definite number of the larvae of the celery leaf-tier were introduced. It was found that the larvae in the calcium arsenate tests continued to feed for four or five days without showing any apparent injury—in fact, if the larvae were removed from the poisoned leaves at the end of the fifth day and fed on unpoisoned foliage from that time on they matured in normal manner and produced moths. On the other hand, where the leaves were dusted with paris green it was found that most of the larvae ceased to feed within one day or two days and they soon died, even if removed and put on fresh foliage.

This probably partially explains why so much poison was required to stop the celery leaf-tier infestations and indicates definitely that paris green is much more efficient in early applications for either the leaf-tier, cutworms or semitropical army worms.

(Note: Since this was written, pyrethrum dusts have been found effective against the leaf-tier and not injurious to celery. Their use is discussed fully in Bulletin 251 of the Florida Experiment Station.)

SUMMARY

Damage to celery in the Florida celery areas is chiefly confined to five different insects: Celery leaf-tier, celery looper, cutworms, semitropical army worm and red spider. (This last is not, strictly speaking, an insect.)

A resume of the seasons since celery has been grown commercially shows that an abnormally warm winter temperature is the main factor in causing outbreaks of the celery leaf-tier, and temperatures within a local producing area may vary enough during the winter season to affect materially the celery leaf-tier situation.

In a normal season the egg parasites and birds contribute to the control of the celery leaf-tier.

There are normally four generations of the celery leaf-tier in Florida in the celery.

Each celery leaf-tier larva consumes during its development about two and one-fourth square inches of a celery leaf. The amount of food remains practically constant regardless of the time required for maturity.

The celery looper (or the closely related cabbage looper) is present on the celery in all sections but rarely in sufficient numbers to be injurious.

Cutworms are a factor in all celery growing areas. Poisoned bran mash applied before planting will largely eliminate them.

The semitropical army worm is present mainly in the fall on small celery and seedbeds. It is not a factor during the main celery growing season.

Red spider, especially during dry seasons, is a serious pest. It can be controlled by timely applications of sulphur and lime.

Bulletin 251 July, 1932

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UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
GAINESVILLE, FLORIDA
Wilmon Newell, Director

(In cooperation with Bureau of Entomology, U. S. D. A.)

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CONTROL OF THE CELERY LEAF-TIER IN FLORIDA

By

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B. L. BOYDEN, *Associate Entomologist*
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CONTROL OF THE CELERY LEAF-TIER IN FLORIDA

BY

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INTRODUCTION

The celery leaf-tier (*Phlyctaenia rubigalis* Guen.) is the major celery insect pest in the Sanford district of Florida. When conditions are favorable for its development, the pest is capable of causing severe losses; however, the weather conditions which usually prevail during the winter months limit its development and it is only during seasons of high temperatures that the insect causes serious damage to the celery crop. It is the caterpillar of a moth.

TYPE OF DAMAGE

Injury by the celery leaf-tier is caused by the feeding of the larvae, or "tiers," on the leaves and stalks of the plant. The young larvae usually feed on the under side of the leaf, but as they near maturity they may eat the entire leaf. When about one-third grown, they begin to web or tie one or more leaves loosely together. Often a larva will tie a part of one leaf to another or to a different part of the same leaf, forming a fold within which it feeds. The pest prefers to feed on the tender, succulent growth just above the heart of the plant, and such feeding results in injured leaves and stalks covered by webbing and castings from the worm's body. (Fig. 1.)

Besides the damage to the crop from actual foliage destroyed, the presence of the worms necessitates a closer stripping of the plants at harvest time to remove the injured leaves. Then also the accumulation of webbing and frass is objectionable and lowers the market value of the product.

METHODS USED TO AVOID LOSSES

EARLY HARVESTING

Early harvesting of celery has been practiced to some extent to avoid injury by the pest. The moths invariably seek the most mature celery on which to lay their eggs. Upon discovering an infestation in a crop that is almost mature, growers often prefer the decreased yield resulting from early harvesting to the expense incident to the control of the pest.

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[1] Transferred to Plant Quarantine and Control Administration Feb. 1, 1928.

CROP REFUSE SHOULD BE PLOWED UNDER

Directly after harvest the crop refuse should be plowed under to destroy the insects left in the field. Larvae and pupae which are shaken off when the plants are being handled at harvest time and those removed with the leaf stalks that are stripped off as unfit for market remain in the field. As the stripped leaf stalks remain succulent for some time, the larger larvae complete their development, emerging later as moths to add to the infestation of the remaining plantings. Counts made in a field having 50 worms per plant showed that as many as six larvae may be left on the strippings from each plant. Pupae and larvae that are well plowed under after harvest of the crop will cease to be a factor in the infestation, for laboratory and cage experiments show that only 33 percent of the moths emerged when the pupae were cov-

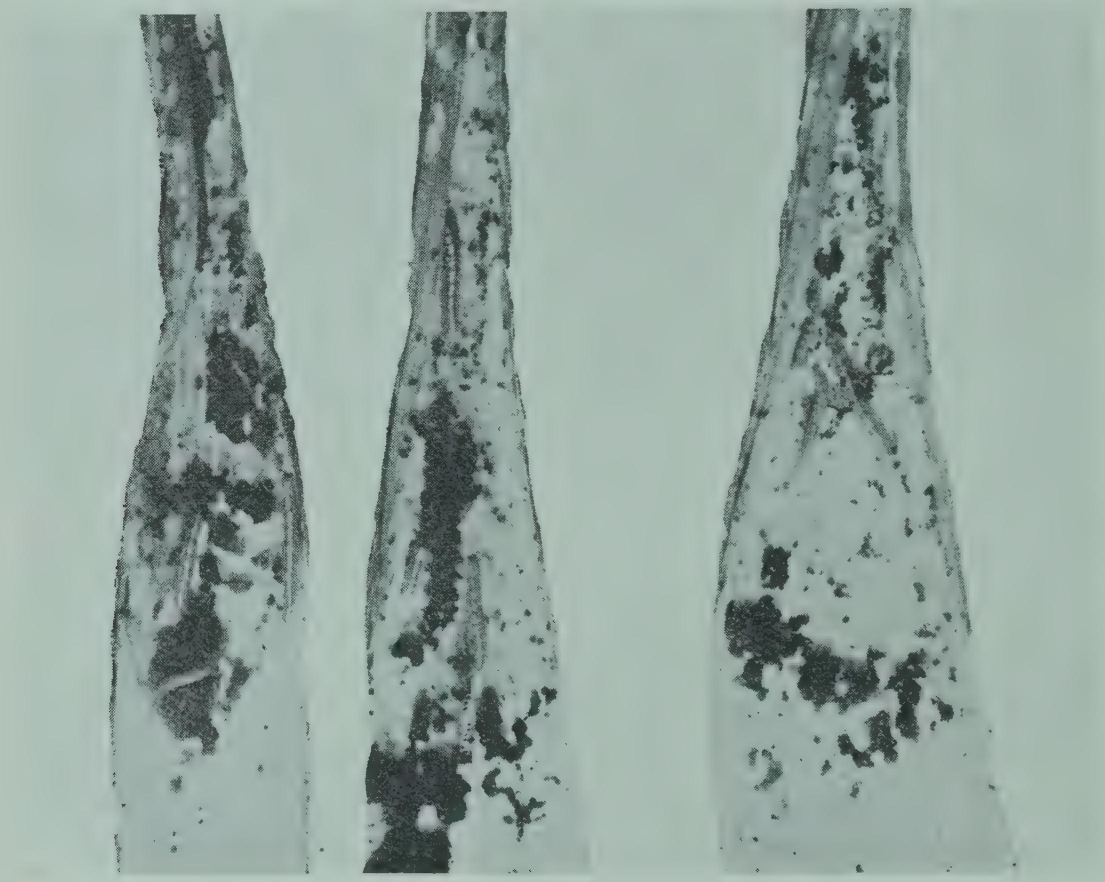

Fig. 1.—Celery petioles showing characteristic injury by celery leaf-tier larvae.

ered by one-half inch of soil, and when covered by more than an inch no moths emerged.[1]

EFFECT OF WASHING THE CELERY

Since 1923 there has been a steady increase in the use of washing equipment in the preparation of celery for the market. These machines aid in the removal, not only of dirt and spray residues, but also in some cases of a considerable number of celery leaf-tier larvae.

Results of tests with washers in which the celery stalks pass through the machine on an endless chain, the water being sprayed under pressure of about 15 pounds from above and below the conveyor belt, showed that only a comparatively small number of the worms were washed from the stalks. Where the water was under a pressure of 55 pounds, about 70 percent of the worms were removed. These tests demonstrate that, although washing does not remove all the celery worms from the plants, it will reduce the number that would otherwise remain on the market product.

USUAL SPRAYING PRACTICES FOR CELERY PESTS

The usual practice for the control of celery blight in the Sanford district is to spray regularly every week or 10 days with a bordeaux mixture 4-4-50 or stronger. A protective covering of the fungicide is thus maintained upon exposed leaves. During the early growth of the celery arsenicals are often added to the bordeaux mixture for the control of celery and cabbage loopers and the semitropical army worm. These insects feed, as a rule, on the outer, exposed leaves, and can be controlled by the usual applications of arsenicals. In the case of the celery leaf-tier, however, the industry is confronted with an insect having entirely different feeding habits; consequently different methods of control are necessary to protect the crop.

OBJECTIONS TO THE USE OF ASENICALS

Applications of arsenicals in the ordinary manner are not adapted to the control of the celery leaf-tier. This insect rarely appears in injurious numbers until within a few weeks of harvesting, and any arsenicals applied at this time will leave poisonous residues on the celery.

---

[1] Field observations by Dayton Stoner, of the U. S. Bureau of Entomology, and R. L. Miller, formerly of the Florida State Plant Board, have confirmed the results of these experiments.

Unpublished data of B. L. Boyden and J. O. Clark show that arsenicals applied as a dust on celery leave a larger proportion of residue on the plants than when a spray is used.

A series of laboratory experiments were made to determine the actual value of arsenicals in the control of the celery leaf-tier. The plants were thoroughly sprayed at the rate of 100 gallons of the mixture to the acre. Colorimetric prints of the leaves showed an even distribution of the arsenical over both upper and lower leaf surfaces, a condition not possible to obtain in commercial sprayings. Tests were made with 2, 3, and 4 pounds of paris green to 100 gallons of water. The 4-pound strength gave good control, but the other dosages were ineffective. Lead arsenate was used in mixtures of 3, 6, and 10 pounds to 100 gallons of water. Only the 10-pound strength showed any measure of effectiveness. Calcium arsenate was tested at the rates of 4, 5, and 8 pounds to 100 gallons of water, with no apparent effect on the celery leaf-tier. These experiments show that excessive dosages of lead arsenate and paris green are required to effect control of the celery leaf-tier under laboratory conditions, and that calcium arsenate is ineffective even when used in large amounts.

These tests, combined with results of field experiments and the experience of the growers, show that arsenicals are of little value against the celery leaf-tier; consequently the use of these poisons is not rcommended.

THE GROWTH OF THE CELERY PLANT AND SPRAY RESIDUES

In connection with the problem of spray and dust residues, records were kept on the growth of several representative plants of both the winter and spring crops of celery. As the celery plant develops the young leaf stalks displace the old ones, which gradually die and fall off. During growth each leaf stalk was tagged and its record was tabulated.

Figure 2 shows the development of a celery plant during the winter season from the time it was set in the field until it was ready for market. It will be noted that 15 leaf stalks dropped from the plant during growth and 10 others were stripped off in the field at harvest, leaving 15 leaf stalks to be crated for market.

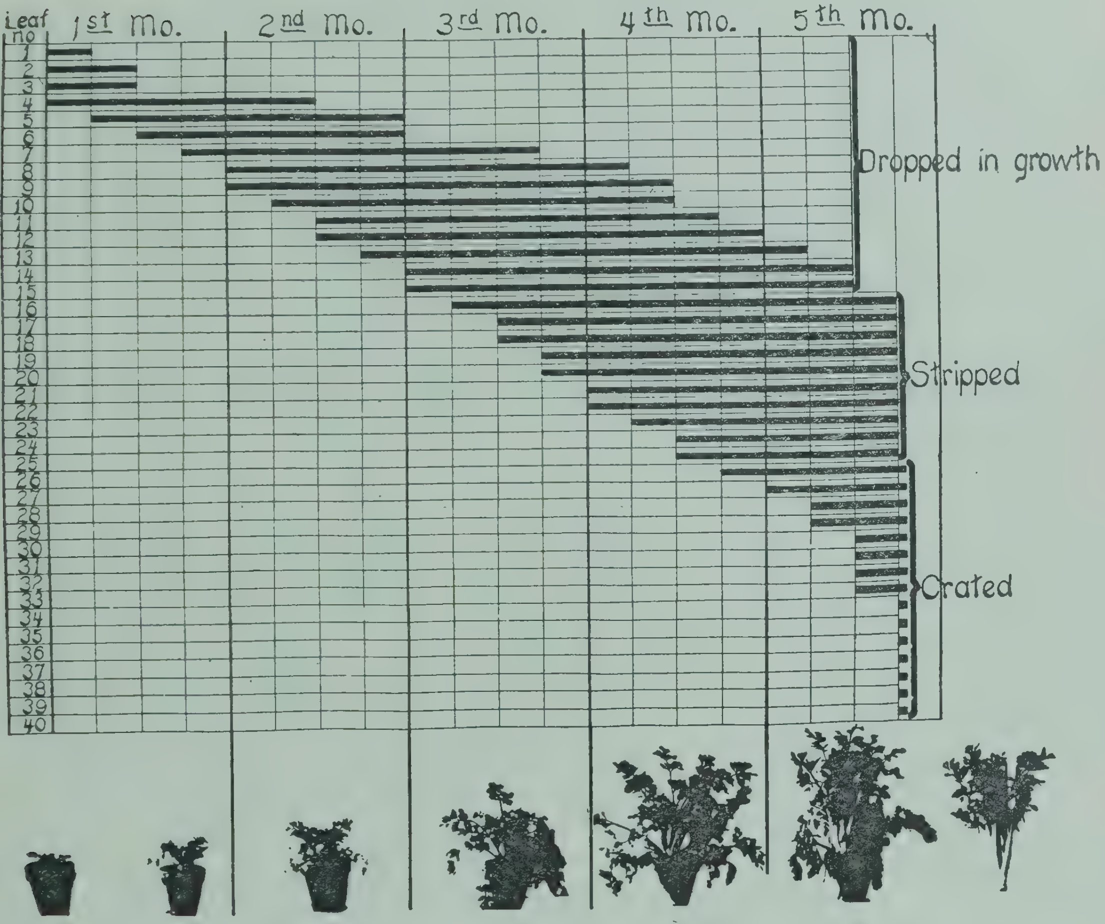

Fig. 2.—Diagrammatic representation of the growth of a celery plant during the winter season.

The development of the plant through each month of the season is illustrated by the photographs at the bottom of Fig. 2.

Figure 3 shows in a like manner the development of a celery plant during the spring season. Although the plants represented in Fig. 2 took almost five months to mature, and those in Fig. 3 only 3 1/3 months, practically the same number of leaf stalks were marketed in each case.

In both the winter and spring crops only that part of the plant which developed during the last five weeks of growth was marketed. As the leaves could not be tagged until they had developed from the bud about a week, such leaves were really formed about six weeks before harvest. In Fig. 3 the oldest leaf that was retained after stripping was between five and six weeks old when the plant was cut for market.

From the growth records shown in Figures 2 and 3 it will be seen that all residue from sprays applied before the last six weeks' period will be removed in the field in connection with harvest; so arsenicals can be applied with safety previous to this time.

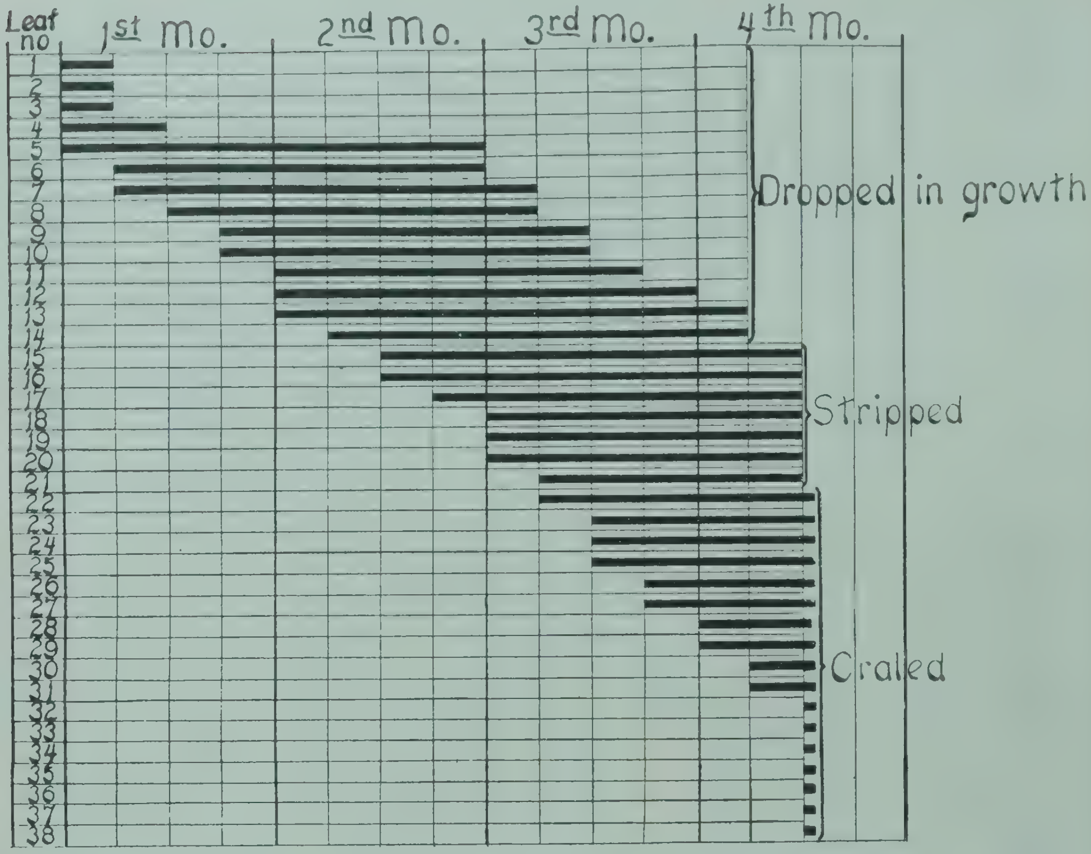

Fig. 3.—Diagrammatic representation of the growth of a celery plant during the spring season.

This practice will control the semitropical army worm and loopers, but will not control the celery leaf-tier.

INSECTICIDE TESTS

Since the celery leaf-tier normally feeds above the heart within the canopy of the celery plant, an ideal insecticide for its control must be harmless to the consumer and also noninjurious to the tender celery heart. In the search for such an insecticide a considerable number of stomach and contact poisons, both dusts and sprays, were used, some of which proved poisonous to the celery leaf-tier larvae but also caused severe foliage injury. Nicotine, in both dust and spray form, an extract of derris, and derris powder were all ineffective. The most satisfactory insecticide tested was pyrethrum dust.

As early as 1896 Quaintance[2] recommended the use of pyrethrum, as either dust or spray, against celery insects. Pyrethrum dust was thus utilized rather generally by the growers throughout the Sanford district for control of the celery leaf-tier, but with varying degrees of success. On account of this lack of uniform control a study was made of the factors which might have a bearing on the effectiveness of pyrethrum.

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[2] Quaintance, A. L.: Insect enemies of truck and garden crops. Fla. Expt. Sta. Bul. 34, 327 p. 1896.

DUSTING VERSUS SPRAYING

The nature of the growth of the celery plant determines the method of application of an insecticide against the celery leaf-tier. The principal varieties of celery grown in Florida are the Golden Self-Blanching and several strains of Special, all of which are noted for their habit of compact growth, as illustrated in Fig. 4.

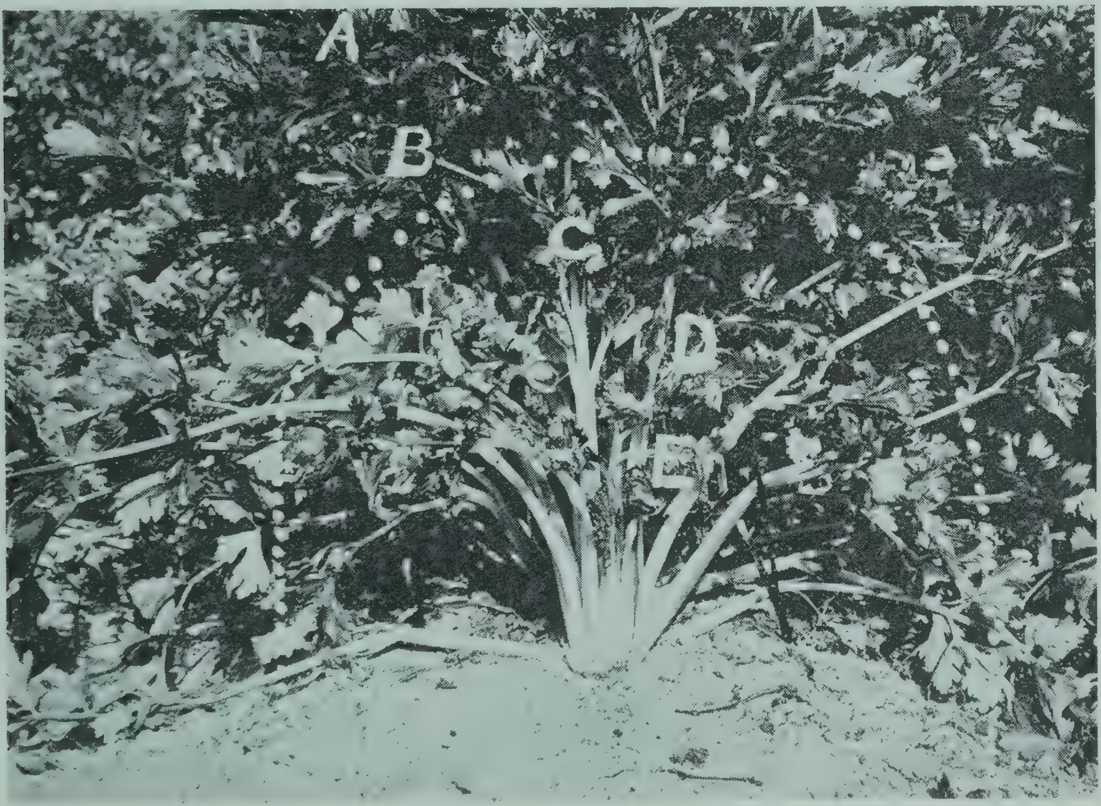

Fig. 4.—Photograph of a celery plant, showing area in which majority of leaf-tier eggs are deposited and illustrating density of growth which necessitates the use of a dust. The letters A, B, C, D and E refer to parts of the plant from which the leaves correspondingly lettered in Fig. 5 were taken.

The method of planting tends to accentuate this compactness, as the plants are spaced three to four inches in the rows, which are 28 or 30 inches apart. Under these conditions the outer canopy of leaves forms an almost impenetrable cover, protecting the inner heart leaves from applications of spray.

Although the celery leaf-tier moths deposit their eggs almost anywhere on the plants, it has been found that the majority are laid within the area surrounded by the outer canopy of leaves, as shown by the dotted line in Fig. 4. On 75 celery plants taken from the field during one season 2,422 eggs were deposited, 68 percent of which were in this part of the plants. The larvae also prefer the more tender leaves of the inner area and tend to concentrate there. Practically all the damage is thus done in the marketable part of the plant.

Sprays, even under high pressure, do not penetrate the outer canopy of leaves and reach the point where they are needed. Figure 5 shows sulphide prints of leaves of both dusted and sprayed celery plants made by the method devised by Hamilton and Smith.[3] The parts of the plants from which leaves were taken are shown by the letters A, B, C, D and E in Fig. 4. The upper surface of each leaf is shown above the letters and the corresponding lower surfaces beneath. It will be noted that the spray was distributed only on the outer canopy of leaves (Fig. 5 above, A and B), and adhered mainly to the upper surfaces, leaving the area subject to celery leaf-tier damage unprotected. On the other hand, the dust penetrated to the heart of the plant, collecting particularly in this area. (Fig. 5 below, C, D, and E.) These results indicate that the nature of the plant growth requires that, to be effective against the celery leaf-tier, an insecticide should be applied as a dust.

CONTROL WITH PYRETHRUM DUST

AGAINST THE MOTHS

Growers will often dust when they see the greatest number of celery leaf-tier moths. Invariably they report a good kill, and the small number of moths remaining in the field after a dusting seems to confirm their contention.

A field having 135 moths per 300-foot row was dusted with pyrethrum. As soon as the dust settled in the plants, the moths, annoyed by the dust, began to rise and drift with the wind from the test area to adjacent fields at the rate of three per second. No dead moths were found the next day. A check on the adjoining fields showed an increase of 10 moths per row while the dusted field showed only 10 moths per row remaining. However, nine days after dusting the treated field became infested with moths

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[3] Hamilton, C. C., and C. M. Smith: A colorimetric method for showing the distribution and quantity of lead arsenate upon sprayed and dusted surfaces. Jour. Econ. Ent. 18:502. 1925.

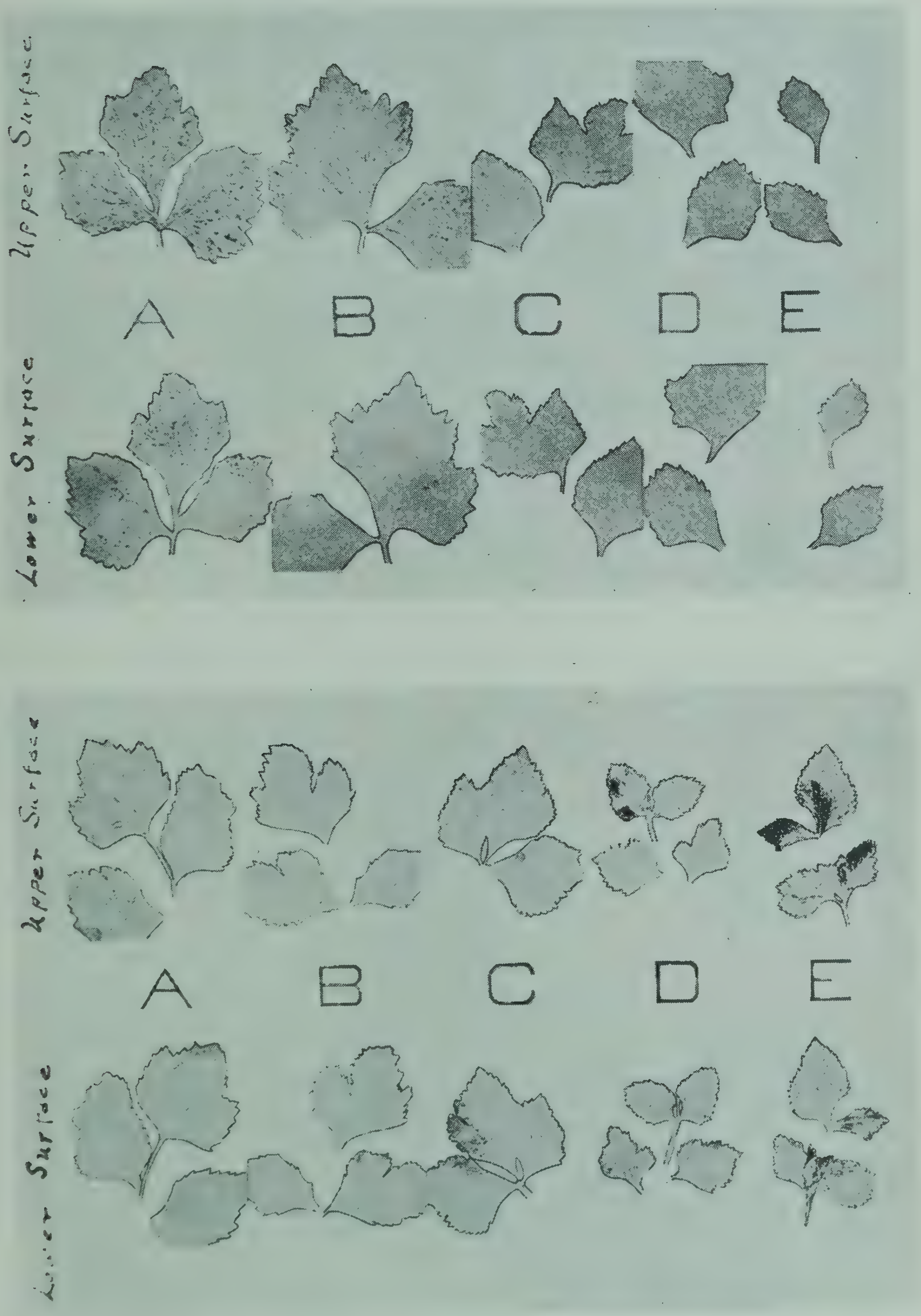

Fig. 5.—Above, pictorial presentation of penetration of spray on celery plants; below, pictorial presentation of penetration of dust on celery plants. The letters A, B, C, D and E in the upper picture show, by reference to Fig. 4, the parts of the plant from which the leaves were taken.

and a second treatment was required to prevent severe damage by the celery leaf-tier. Dusting for moths of the celery leaf-tier therefore is of doubtful value, for few moths are killed and others are driven to neighboring fields where they may intensify a mild infestation in younger celery.

When tree swallows, which destroy large numbers of moths, are present, dusting for moths is of some value, as the pyrethrum disturbs the moths and allows the swallows which swoop over the dusted field an opportunity to capture them.

Laboratory tests show that pyrethrum dust actually kills the moths when they are dusted in a confined space. In this case, however, the dust is applied directly to the moths, under conditions unobtainable in the open field.

AGAINST THE EGGS

The belief that pyrethrum dust kills the eggs of the pest has been advanced by some celery growers. In an effort to find out what effect, if any, pyrethrum had on the eggs of the celery leaf-tier, pyrethrum in varying quantities was placed on fresh celery leaf-tier eggs on leaves in the laboratory and allowed to remain for the period of incubation. Less than 20 percent of the eggs treated in this way failed to hatch. Untreated eggs used as checks all hatched. These eggs receive a heavier and more even application of dust than would be possible in the field. In the case of plants brought from a field dusted heavily with pyrethrum only 6 percent of the eggs failed to hatch.

AGAINST THE LARVAE

Pyrethrum is more effective against the larva of the celery leaf-tier than against any other stage of the insect's development. A very small quantity of the dust adhering to the skin of a tier will induce excitability, followed in a few minutes by partial paralysis and finally by death. Both laboratory experiments and field observations show that all larvae receiving a very small quantity of pyrethrum dust are killed. The minimum lethal dose of pyrethrum has not yet been determined, as it varies with the size of the larvae. However, it appears that a minute quantity of fresh pyrethrum dust scattered over the body of the larva is all that is required.

PROPER APPLICATION OF PYRETHRUM DUST

DUSTING MACHINERY

Many attempts were made by the growers to secure control in the field by applying pyrethrum dust with some form of hand duster. Invariably a poor kill of the celery leaf-tier resulted; consequently, it was claimed that control could not be secured by the use of pyrethrum. Careful tests showed that the method of application was at fault and not the pyrethrum. With the hand dusters it was impossible to place the dust under the outer canopy of leaves.

In the Sanford district the horse or mule drawn traction duster of the four-row type is used. Figure 6 shows this type of duster with the discharge pipes arranged to show the different methods used in the application of dusts. These dusters all apply varying quantities of pyrethrum, but the older models are limited to a maximum of about 25 pounds per acre. When tested against one another, or observed under similar conditions, there appears to be very little choice between various makes of machines. The chief difficulty with these machines has been that the flow of dust is not continuous and an uneven distribution of dust results.

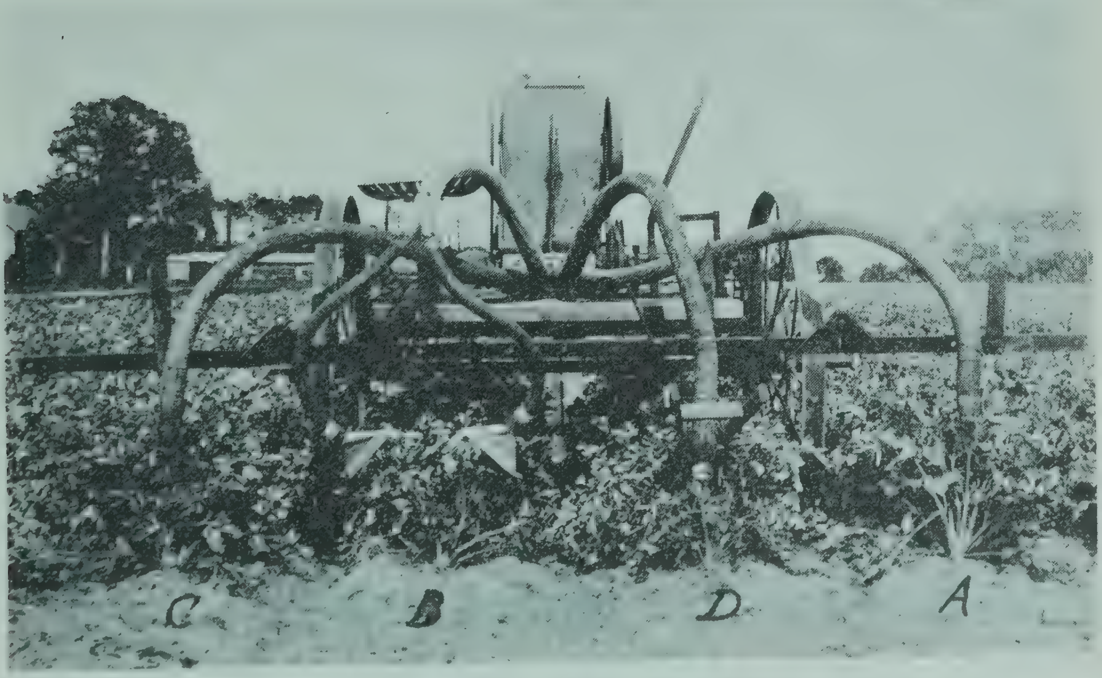

Fig. 6.—Traction duster with different arrangement of pipes in use in the Sanford district, and plow attachment used in experimental work in an effort to secure better penetration of dust. A, discharge pipe too high above plants; B, nozzle arrangement of this type is of no value; C, proper adjustment, outlet well down in plant row; D, special "plow" attachment for opening canopy of leaves.

The new models mix the dust with the air in the fan chamber and have a force feed from the hopper which gives a continuous flow of dust so that better control can be expected.

ARRANGEMENT OF DUSTER PIPES

Under optimum conditions—i. e., little wind, dry plants, and high temperature—many growers were securing a kill not exceeding 10 or 15 percent of the larvae present, while others were getting very good control. It appeared, therefore, that the deciding factors must be the method and the time of application of the dust in relation to the stage of larval development.

In Fig. 6 are shown various arrangements of the discharge pipes for applying the dust, all attached to the same duster. A shows the usual method of application, with the opening of the pipe entirely above the celery plant. With this arrangement very little of the dust is forced through the outer canopy of leaves, and even a slight breeze dissipates the dust before it can settle into the plants. B shows the method used in the application of fungicides for disease control. The difficulty of securing penetration through the overhanging leaves is evident. C illustrates the method of application found to give the best control under all conditions. The outlet of the duster pipe has been placed as low as possible in the celery plant, so that the dust is discharged within the canopy of leaves, rebounding and drifting throughout the plant. D illustrates a "plow" arrangement designed to open the plants in front of the lowered pipe shown in C. This arrangement gave only a slight increase in control, which did not compensate for the time required to keep the "plow" properly adjusted.

A kill of from 10 to 25 percent is all that can be expected when the pipe opening is above normal celery plants. The maximum kill was only about 65 percent and was obtained when the plants had rather short stalks with an open canopy due to abnormal growth during the warm spring weather. Likewise the kill secured by using two nozzles, one on each side of the row, was poor. A 30 percent kill with the old-model dusters arranged in this manner is considered high.

Figure 7 shows all four discharge pipes arranged in the proper manner to give the best control. Despite the compact growth of the celery plants, the lowered pipes are drawn through the leaves with a negligible amount of injury to the plant. Dust applied in this way covers the heart leaves, as shown by the sulphide prints in Fig. 5.

No rule for the setting of the pipes can be given, owing to differences in the growth of celery. They must be placed deep enough to deposit dust on the heart of the celery plant without actually coming into contact with it. If no dust is found on the heart of the plant after dusting, a poor kill is likely to result.

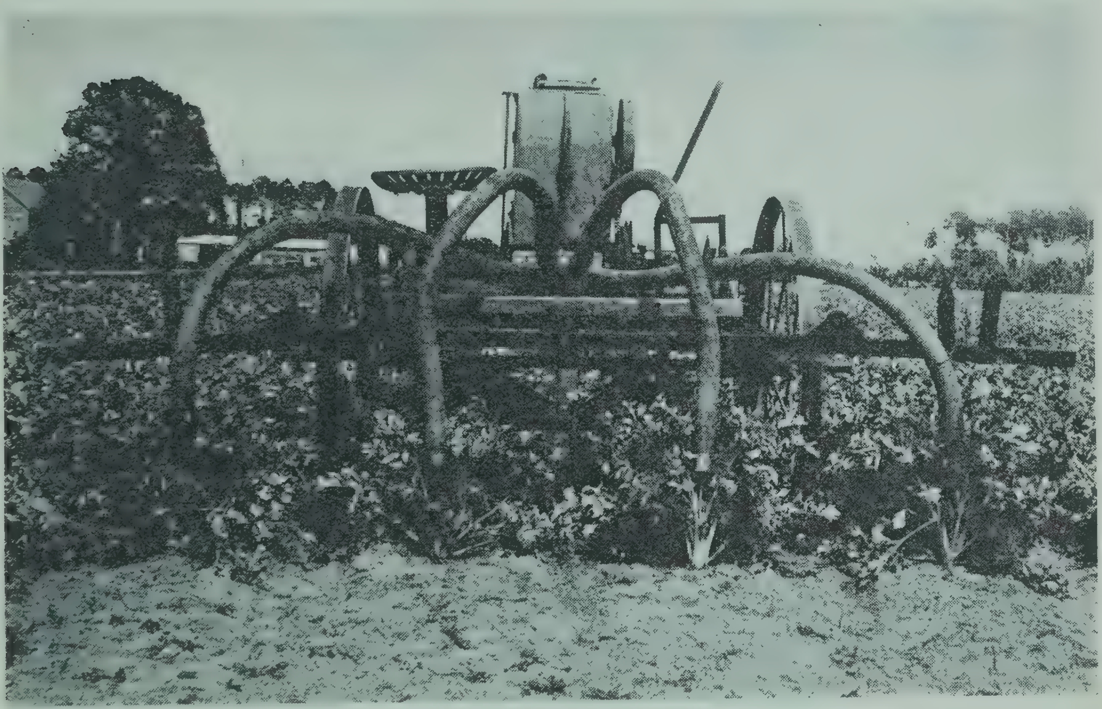

Fig. 7.—Proper arrangement of dusting pipes to secure maximum control of the celery leaf-tier.

The method of planting celery in the Sanford district is so exact that when the pipes are set at a certain depth and spaced for the rows an entire field can be covered with only minor adjustments.

DUST MOST EFFECTIVE ON YOUNG LARVAE

A factor equally as important as the adjustment of the dusting machine is the stage of development of the larvae. Many times a celery leaf-tier outbreak is not noticed until the larvae are half grown or larger and have protected themselves by webbing the leaves together. When this is the case a kill sufficient to control is not obtained even when pyrethrum is applied under proper conditions, with the pipes deep in the plants. A kill of 65 percent of the larvae, when dusting is delayed until they are two-thirds grown, is obtained only under the most favorable dusting conditions.

EFFECT OF WIND, TEMPERATURE, AND MOISTURE

During past seasons many tons of pyrethrum dust were applied while medium or fairly high winds were blowing. Pyrethrum dust is a very light substance that will drift with any breeze, dissipating itself above the plants without coming into contact with the insects. The properties that make it so well adapted to dusting demand a quiet day for proper application. When fields are dusted on windy days, the kills are never more than 65 percent and usually are much smaller.

A common practice when dusting during windy weather is to drag cloth trailers behind the duster, as shown in Fig. 8. This apron is supposed to hold the dust over the plants long enough to allow it to penetrate. An experiment, conducted during a 13-mile wind, showed that dusting without the apron gave control as good as, if not better than, was obtained with its use, although both methods gave poorer control than was obtained on a calm day.

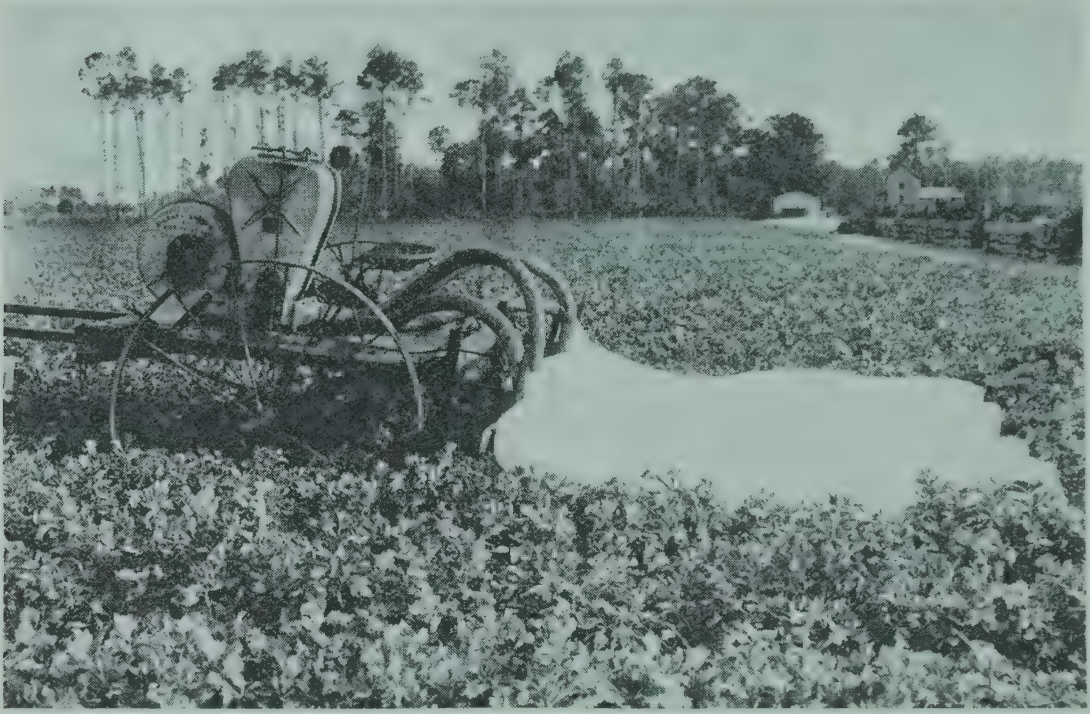

Fig. 8.—Traction duster with trailer attachment which, experiments prove, is of no value in confining dust to the celery plants.

It is well known among growers that, other things being equal, the best control is secured when pyrethrum is applied on a warm day. The effect of temperature upon the reaction of pyrethrum is not understood, but it is known that temperature directly affects the activity of the celery leaf-tier larvae. This activity on a warm day undoubtedly increases the likelihood of a larva's coming in contact with the dust.

During a series of windy days many growers, realizing the waste involved in dusting during the day, when the wind is high, dust at night or early in the morning. This practice is recommended if done at a time when there is little dew or other moisture on the celery. Plants from fields dusted while damp showed caked areas of dust just below the nozzle openings, indicating poor distribution. Since under such conditions the dust adheres to the wet leaves and does not circulate through the leaf stalks of the plant, a large proportion of the larvae escape contact with the pyrethrum.

COMPARATIVE EFFICIENCY OF UNDILUTED PYRETHRUM AND VARIOUS MIXTURES

Only closed-flower pyrethrum of the best grade obtainable has been used in the Sanford area, and it has thus far been applied full strength at the rate of 40 to 50 pounds per acre in two applications about 30 minutes apart. Good control has not been accomplished by one application of pyrethrum, because it is seldom possible for the dust to penetrate between the webbed leaves in sufficient quantities to effect a satisfactory kill. The larvae are, however, irritated sufficiently by the first dusting to cause them to move about in the plants, and they will thus receive a lethal dose from the second application.

As the price of pyrethrum increased from 30 cents per pound in 1927 to 50 cents per pound in 1929, it became imperative that the cost of control be reduced. Experiments during the season of 1928-29 were made with Japanese pyrethrum flower dust, which is much cheaper than closed-flower dust, as it consists of both open and closed flowers ground together. Mixtures of this dust with hydrated lime and sulphur dust were tested experimentally. Lime was used because of its good dusting qualities and low price, sulphur because of its value in controlling the red spider.

Early-season experiments under unfavorable conditions showed that a 50 percent mixture promised as good control as did the undiluted pyrethrum, when both were applied in the same quantity. Under as near ideal conditions as possible, a series of tests were made which definitely showed the value of these mixtures in controlling the celery leaf-tier. A fairly heavily infested field of celery was chosen and careful counts were made as a check the day before the dusts were applied. Approximately 20 percent of the larvae present were well over half grown, while the remaining 80 percent ranged from newly hatched to nearly half grown larvae. The discharge pipes of the duster were kept as deep in the celery as possible. The results of these experiments, given in Table I, show a kill with 50 percent mixtures equal to that from the undiluted pyrethrum. Double application of the pyrethrum-lime dust gave a kill of 91 percent, the best secured. The diluted dust was used at a rate of approximately 50 pounds per acre, in two applications of 25 pounds each, at intervals of 30 minutes. The second best kill, 88.4 percent, was obtained from the pyrethrum alone applied at the rate of approximately 40 pounds to the acre in two applications, as used in the other test.

When pyrethrum mixtures are used, it is recommended that the lime or sulphur be mixed with the pyrethrum immediately before application, as it is not known how long the pyrethrum will retain its effectiveness when mixed with these materials. It is essential

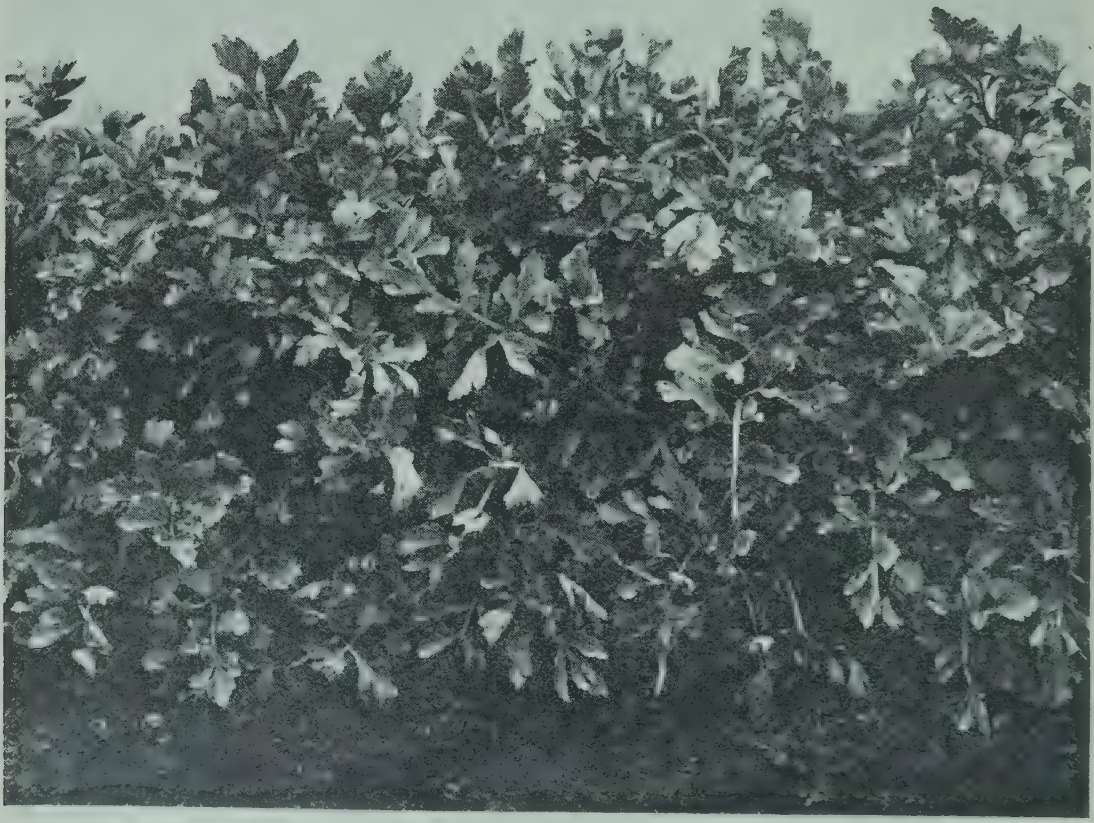

Fig. 9.—Section of an infested celery row 10 days after being dusted with a pyrethrum-sulphur mixture.

TABLE I.—EFFECT OF PYRETHRUM DUSTS UPON MORTALITY OF THE CELERY LEAF-TIER IN EXPERIMENTS CONDUCTED DURING THE SEASON OF 1928-29.

Plot No.	Dust applied	Applications	Quantity of dust per acre	Quantity of pyrethrum per arce	Larvae counted alive per plant 24 hours after dusting			Kill 24 hours after dusting		
					Small	Large	Total	Small	Large	Total
		Number	Pounds	Pounds	Number	Number	Number	Percent	Percent	Percent
1	Pyrethrum	1	19	19	6.6	5.4	12.0	83.3	47.5	76.0
2	do	2	38	38	2.1	3.6	5.7	94.7	65.0	88.6
3	do	3	57	57	2.6	3.9	6.5	93.4	62.1	87.0
4	Pyrethrum 50, Lime 50	1	27	13.5	7.2	3.6	10.8	81.8	65.0	78.4
5	do	2	54	27	2.0	2.4	4.4	94.9	76.7	91.2
6	Pyrethrum 50, Sulphur 50	1	23	11.5	11.0	4.5	15.5	72.2	56.3	69.0
7	do	2	46	23	7.6	4.7	12.3	80.8	54.3	75.4
8	Pyrethrum 50, Sulphur 25, Lime 25	1	29	14.5	6.8	3.8	10.6	73.3	56.8	69.0
9	do	2	58	29	4.0	2.8	6.8	84.3	68.1	80.2
	Counts on plots Nos. 1 to 7 preceding dusting				39.7	10.3	50.0			
	Counts on plots Nos. 8 and 9 preceding dusting				25.5	8.8	34.3			

that the pyrethrum be thoroughly mixed with the carrier. Any ordinary dust mixer, such as one of the common barrel type, is satisfactory. The mixing should not be left to irresponsible help. Freshly-ground pyrethrum should be secured whenever possible, as in a humid climate the dust tends to cake and harden.

A comparison of the percentages of small and large larvae killed shows an average of 22 percent increase in kill among the small larvae for the four dusts tested, indicating the value of dusting when the larvae are very small. A severe infestation can be predicted when a large number of moths are flushed out of the celery in the course of normal cultural operations. Soon after most of the moths have disappeared it is time to look for leaf-tier damage. If, upon opening the leaves of the canopy, it is found that the tender foliage above the heart is being skeletonized by the young larvae, dusting cannot be delayed many days if good control is to be obtained.

Figure 9 shows celery plants taken from the sulphur-pyrethrum plot 10 days after receiving two applications of dust. Though only a 75 percent kill was secured on this plot, the plants

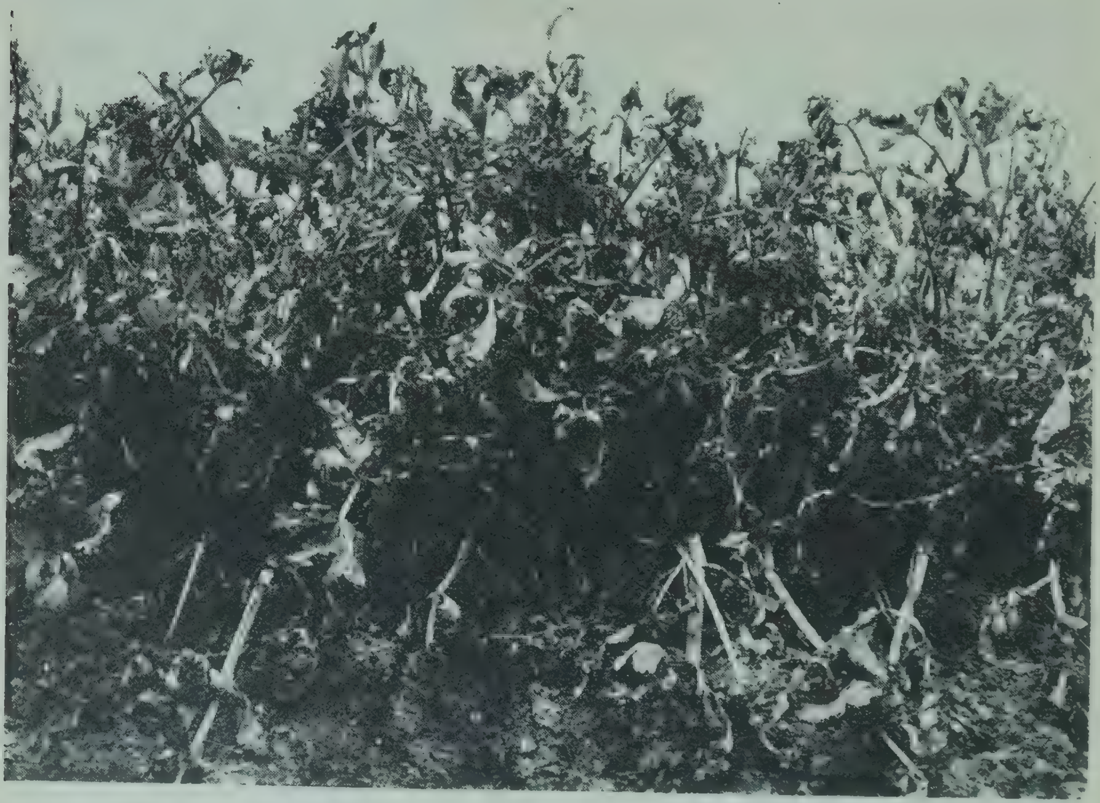

Fig. 10.—Section of celery row in check plot, showing destruction by the celery leaf-tier 10 days after adjacent plots were dusted with pyrethrum. See Fig. 9.

were not damaged by the leaf-tier. An adjacent undusted plot photographed at the same time is shown in Fig. 10. The celery in this check plot was completely destroyed by the feeding of the larvae. This shows the amount of damage accomplished by a large number of larvae in the short period required for their development.

The increased kill due to the second application for each of the four dusts used was found to average 11 percent, or five larvae per plant. Where celery growth is retarded by warm weather or other unfavorable conditions, this number is sufficient to cause considerable damage in the period before harvest.

SUMMARY

Celery leaf-tier damage results in a smaller yield of celery, due to heavy stripping, and in a product that is of lower market value.

Proper cultural and harvesting practices are useful in aiding in the control of this insect.

Arsenicals are of little value in controlling the celery leaf-tier, and in addition their use may result in a dangerous arsenical residue in the harvested product.

Fresh pyrethrum dust, either alone or mixed with lime or sulphur, applied to dry plants on a calm day with a traction duster, is effective against the larvae of the celery leaf-tier.

Pyrethrum dust must reach the heart of the celery plant in order to be effective against the celery leaf-tier.

The treatments should be directed against the immature larvae as they are more susceptible to the action of the pyrethrum than the nearly mature forms.

Bulletin 267 May, 1934

UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
GAINESVILLE, FLORIDA
Wilmon Newell, Director

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STUDIES ON THE RING SPOT DISEASE OF SUGARCANE

By B. A. Bourne

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STUDIES ON THE RING SPOT DISEASE OF SUGARCANE[1]

By B. A. BOURNE

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INTRODUCTION

A number of fungous diseases affecting the leaves of sugarcane have been made the subject of intensive study during recent years, more especially those caused by various species of the genus *Helminthosporium.* Although existing records show that the common "ring spot" disease was described about 40 years ago, little detailed research has been carried on concerning this malady. It has also been interesting to note that for a considerable number of years after a causal organism had been assigned to the disease, differences in opinion existed as to the identity of the true parasite.

Subsequent to the researches of Butler*(13)*[2] however, in 1918, no further studies appear to have been made with this disease other than an extension of our knowledge of its geographical range by numerous plant pathologists and mycologists. These latter, of course, were guided in their identification work by previously published descriptions of the disease. The finding of the fungus *Leptosphaeria sacchari* van Breda de Haan associated with typical lesions was taken as final evidence that the disease was present.

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[1] Also presented to the Faculty of the Graduate School of Cornell University, June, 1933, as a major thesis in partial fulfillment of the requirements for the degree of doctor of philosophy. (Abridged for publication.) Grateful acknowledgement is made to Dr. L. M. Massey, Dr. C. E. F. Guterman, Dr. H. E. Thomas and Professor H. H. Whetzel of the Department of Plant Pathology and Dr. O. F. Curtis of the Department of Plant Physiology for helpful suggestions and criticisms.

[2] Numbers in parenthesis (Italic) refer to "Literature Cited" in the back of this bulletin.

This paper is the outcome of investigations conducted to determine the true nature of the so-called "ring spot" disease of sugarcane and to make such physiological and basic studies as would enable cane breeders to appreciate fully certain factors likely to be significant in the process of developing new types resistant or immune to the malady.

Most of the results reported were obtained during the period 1930-1933 in the Lake Okeechobee region of Florida,[3] where one of the largest sugarcane* developments in the State is in progress. However, observations on the disease were made on a large number of cane varieties planted in scattered sections of the State so as to gain some idea as to the influence of such environmental factors as climate and soil. Further, some of the physiological and mycological studies were made in the laboratories of Cornell University, where adequate facilities were available.

THE DISEASE

NAMES, HISTORY AND GEOGRAPHICAL RANGE

The disease was first briefly described by Krüger*(37)* in 1890 as the ring spot of the cane leaf. Later, 1892, van Breda de Haan*(56)*, described the malady in greater detail, retaining the same name. Wakker and Went*(58)*, Butler*(13)*, Bancroft*(7)*, Johnston and Stevenson*(35)*, Nowell*(46)*, Cook*(18, 19, 20)*, Lee and Martin*(41)*, as well as several others, have rigidly held to the original name. In only one instance has the writer detected a departure from this original designation and that is in a paper by Horne*(32)* in 1905, well illustrating the typical lesions, but making reference to it under the name of "eye spot" ("la enfermedad mancha de ojo"). Since the disease was first described under the name of "ring spot" it would be most desirable to give priority to this original name in all references to the malady in order to avoid confusion.

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[3] The use of laboratory and other facilities furnished cooperatively by the Southern Sugar Company and the United States Sugar Corporation is much appreciated.

*The use of the term "sugarcane" as one word instead of being hyphenated (see original thesis, Cornell University Library), or as two words (as adopted and published in the Proceedings of the 4th Congress of the International Society of Sugar Cane Technologists, 1933: p. 150. Porto Rico), is one of editorial policy for which the author is in no way responsible.

By perusal of the literature, it is seen that since the malady was first described from Java where it occurs especially in the western portion rather than in the dry plains of East Java, it has been recorded from practically every cane producing country. The main references are to be found by Horne*(32)* 1905, Butler*(12)* 1906, Cobb*(16, 17)* 1906 and 1909, Bancroft*(7)* 1910, Averna-Saccá*(6)* 1916, Johnston and Stevenson*(35)* 1917, Caum*(14)* 1921, Lee*(38)* 1924, Anderson et al.*(3)* 1926, Stevenson*(53)* 1926, Abbott*(1)* 1929, Bell*(9)* 1929, Chardon, Toro et al.*(15)* 1930 and Cook*(21)* 1931. According to these, the disease has been found in Java, India, Singapore, Borneo, Hawaii, Philippines, Australia, Fiji, South Africa, Argentina, Brazil, Peru, Mauritius, Cuba, Santo Domingo, Porto Rico, British West Indies, Panama (Canal Zone), Columbia (N.W. of Palmira) and Florida and Alabama of the United States.

ECONOMIC IMPORTANCE

After reviewing the estimates of damage caused by the ring spot disease as given by van Breda de Haan*(56)*, Wakker and Went*(58)*, Horne*(32)* and Butler*(13)*, it is evident that several authors agree that while the disease as a whole has never been considered as being of much economic importance, certain environmental conditions not thoroughly understood have been associated with very serious local outbreaks. Bell*(9)* has also noted that the disease materially affected some of the newer Hawaiian seedlings and points out that like eye spot, it may become of special importance to cane breeders.

The writer has seen very severe outbreaks of this disease on susceptible varieties in Barbados, Porto Rico, Cuba and in several places in Florida. The view taken by some, especially Lee and Martin*(41)*, Cook*(20)* and others that the disease occurs almost entirely on the outer and older leaves and thus is not as important as certain diseases due to *Helminthosporium* spp. which attack the young leaves is not concurred in by the writer subsequent to the studies on the true nature of the etiology of the disease and a recognition of the fact that the parasite is able to attack various parts of the host in addition to the leaves.

Because several commercial canes at present grown in Florida are highly resistant to the malady, the loss in this State is not considered to be of major importance for the most part. However, the damage to certain susceptible varieties is very severe, although difficult to evaluate properly. Again, it must be admitted that otherwise excellent new seedling varieties might have to be discarded or severely limited to special locations in the future on account of high susceptibility to this disease. There can be no doubt that the disease would become of distinctly major importance unless adequate precautions were taken to select only highly resistant canes for use commercially.

SYMPTOMATOLOGY

MORPHOLOGIC SYMPTOMS AND EXTERNAL SIGNS

The Leaves:—Van Breda de Haan*(56)* and Wakker and Went*(58)* all agree in their description of the morphological symptoms of the disease. Butler*(13)* however, makes no mention of dark green spots in the early stages of the malady, but regards the first symptoms as being the appearance of small discolored, generally purple spots visible on both surfaces of the leaf. Cook*(20)* states that the first symptoms are exhibited by the appearance of small yellow spots which increase in size and show a black color in the center. The illustration published by this latter author shows numerous almost entirely black spots not at all typical of the ring spot as illustrated by several authors, including Wakker and Went*(58)*, Butler*(13)*, Nowell*(46)* and Bell*(9)*.

In Florida, typical ring spots usually appear very frequently on susceptible cane varieties in early December and January. Using the color standards of Maerz and Paul*(43)*, the young spots first appear superficially as minute ivy green to bronze brown, somewhat elongated flecks which enlarge to become lesions varying in color from Burgundy and India red to Spanish raisin, with a distinct yellow areola. Fig. 1[4] shows lesions occurring on the varieties CP. 27-139[5] and Otaheite, which bring out the variations which have been observed. Fig. 4 shows the typical appearance of the early stage of infection on Otaheite leaves after 14 hours under artificially controlled conditions. While only the straw-colored spots are typical of what have been described previously as ring spots, the darker lesions having similar shape

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[4] Reproduced from a photograph in full color as filed with thesis.

[5] Cane varieties are designated differently in various countries. In Florida, "CP" and "US" canes refer to those bred by the U. S. Dept. of Agric. at their Canal Point Station, while the "F" series refer to those bred for the Florida Agric. Exp. Sta. "POJ" and "Co" canes refer respectively to those bred by the Java Exp. Sta. and the sugarcane Station at Coimbatore, India.

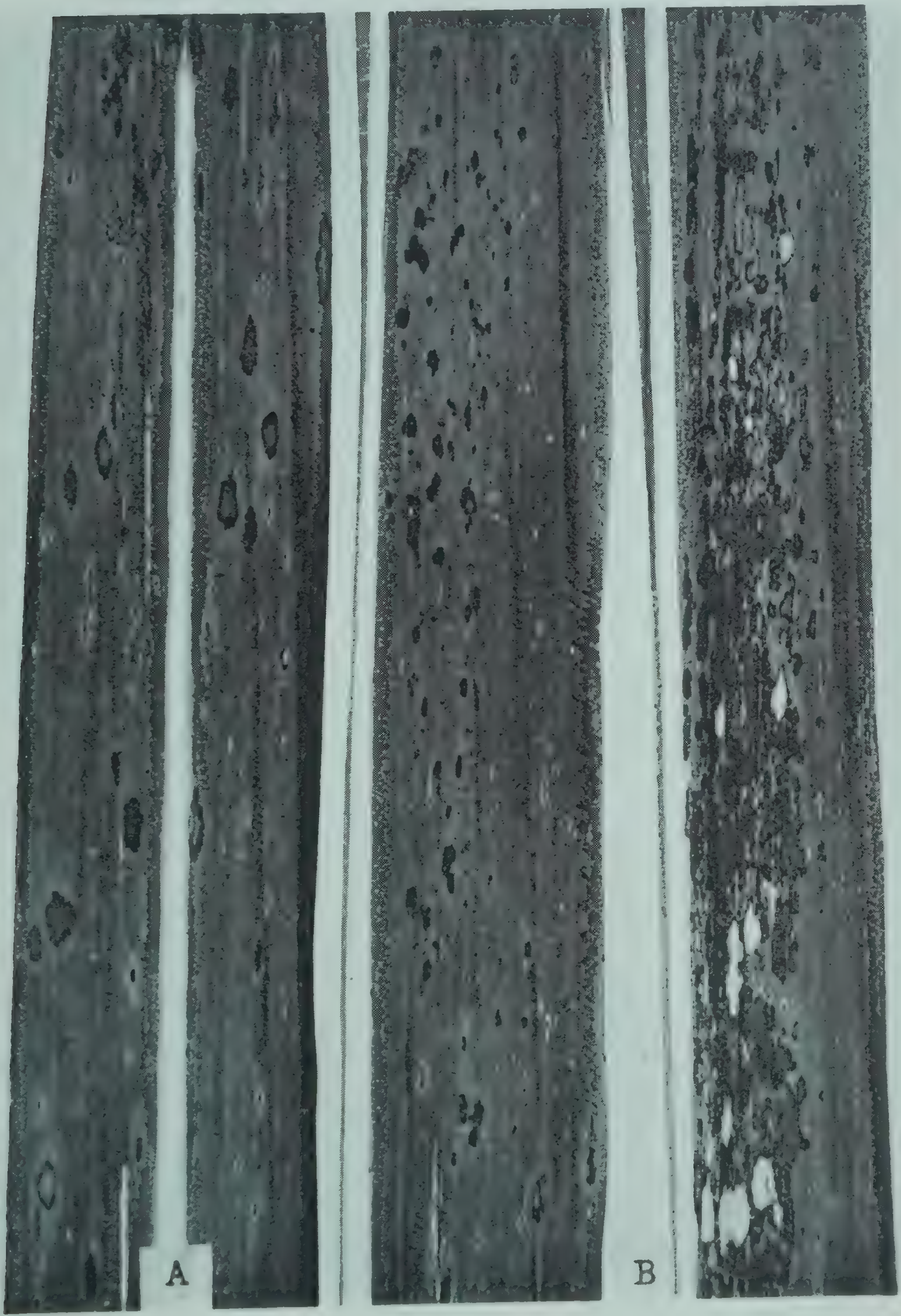

Fig. 1.—Typical ring spots on leaves of sugarcane. A, leaf of CP. 27-139; B, two half leaf portions of Otaheite.

have also been found to be caused by the same pathogenic organism.

When about 2 mm. wide by 5 mm. long, the length being always greatest in the direction of the leaf veins, an oval portion of the center often turns an antique bronze, outside of which is a Burgundy or Spanish raisin colored narrow-oval border surrounded by a yellow areola. By the time the spot enlarges to its full size—2.5-4x10-12 mms. or sometimes larger—it usually loses its oval form and becomes somewhat irregular in outline, the ends becoming rather pointed and elongate, often giving the spots a spindle-shaped appearance. At this stage, the center frequently becomes peach blow to straw-colored, while the narrow margin remains Spanish raisin in color. The yellowish areola often disappears laterally as the spot reaches its full size, but is plainly visible at both ends, in some cases extending 5 mms. or less as a pointed yellow streak, mainly in the direction of the leaf tip.

It often happens that two or three spots will coalesce either laterally or longitudinally, and the margins which come in contact eventually disappear, leaving a large irregularly shaped blotch with a Burgundy or Spanish raisin colored margin about 0.5 mms. wide. The narrow margin is usually thicker at the ends than laterally. Also, instead of forming fairly well defined lesions, very irregular and much elongated streaks frequently occur, especially toward the leaf tip, these streaks often having a typical oxheart-colored appearance.

While the centers of the spots usually become straw-colored, this phenomenon does not always take place, as clearly illustrated in Fig. 1, the spots remaining bronze brown, antique bronze or Spanish raisin in color with perhaps only a mere fleck of a paler portion at or near the center. Occasionally, spots enlarge considerably while yet maintaining an ivy green color with a rather sharp margin of bronze brown. Such "green" spots have been mentioned by van Breda de Haan*(56)* in his original description of the disease in Java.

The writer has also confirmed Butler's observations relative to the withering of the leaf tissues in the neighborhood of the spots in the later stages of the disease, so that in cases of heavy infection the whole leaf withers prematurely.

Should the center of the spot become peach blow or straw colored, minute black points are commonly visible on the upper surface between the fine veins, both in the center and also bordering on the Burgundy or Spanish raisin colored plesionecrotic marginal area. These black points represent, as will be brought out later, the fruiting bodies of one or both of two frequently associated saprophytic fungi.

While the mid-rib has never been found to have a typical spot on it, infections starting on the border of this leaf portion often encroach on it laterally.

Lesions may occur on any portion of the green leaf blade, both on the central as well as outer whorl of leaves, but appear to be more numerous as a rule from the central portion toward the tip, especially among stools of canes along the edge of the field or in locations favorable for the deposition of dew on the leaf surface. Fig. 5 shows the appearance of typical lesions at the base of the leaf blade.

The Leaf-Sheath:—Caum*(14)* in 1921, gave a description and diagnosis of a leaf-sheath disease of sugarcane in Hawaii which agrees well with certain stages of ring spot disease as it affects the sheath in Florida. He also described the fungus associated with the disease as one forming pycnidia on the spots. This author states that the fungus attacks practically all the varieties grown in Hawaii and is primarily a leaf-sheath parasite, attacking the sheath at or near the point of attachment, killing the tissues and causing the formation of characteristic spots.

In Florida, one of the same saprophytic organisms which has been found associated with the ring spots of the leaf blade, forming minute blackish points, also occurs on the leaf-sheath along with the true parasite. The young spots appear as minute discolored areas which soon turn a Burgundy to Spanish raisin color. The lesions frequently become oval or irregular in outline and the center may dry out, becoming peach blow or straw colored as in the case of the leaf spots, having a sharp, narrow margin of Burgundy or Spanish raisin colored plesionecrotic tissue. Other lesions remain bronze brown or Spanish raisin in color and show no drying out in the center. Fig. 5 shows some of the lesions on sheaths of D.74 with and without dry straw-colored centers. Occasionally the edge of the leaf-sheath is attacked and the parasite kills it back throughout its length for a considerable depth, leaving it very often straw-colored with a narrow Burgundy or Spanish raisin colored margin next to the healthy tissue.

The Stem:—Caum*(14)*, as noted above, records the occurrence of the sheath disease on the stem also, especially in the case of particularly susceptible varieties. In fact, in some instances all the rind on the internode was found destroyed by the organism forming pycnidia which the author claims to be parasitic. The typical lesions on the stem, however, were neither described nor figured.

The writer has found abundant lesions on the stems of many susceptible varieties, these being especially large when stalks are mature and ready for fabrication. Fig. 6 shows typical lesions on three canes. Spots vary from minute, oval or roundish dots to areas of considerable size. As in the leaf and sheath spots, the outline is irregular, but there exists a tendency to considerable elongation, sometimes extending to about 11 cms. In most cases, the center of the spot is characteristically aluminum to straw colored. The edge of the lesion is sharply defined against the normal tissue and may be Burgundy, Spanish raisin or bronze brown in color. However, many lesions show no such coloration in the plesionecrotic zone, but are aluminum colored up to the very edge of the lesion. A hand lens reveals very readily the protruding pycnidia of the associated saprophyte scattered indiscriminately over the surface of the light-colored areas, instead of being arranged in rows as in the case of the leaf lesions.

HISTOLOGICAL SYMPTOMS AND INTERNAL SIGNS

The Leaf:—The histological symptoms and signs of the ring spot disease have previously been described by van Breda de Haan*(56)*, Wakker and Went*(58)* and Butler*(13)*, special emphasis in all cases being placed on signs of *Leptosphaeria sacchari,* which was considered the cause of the pathological condition. In making a study of these symptoms, the writer used material collected in the field as well as artificially induced spots by infecting leaves, sheaths and stems with a pure culture of the causal organism under controlled conditions. Material was cut both free-hand in the living condition and by means of a microtome, after fixation and imbedding in paraffin by the usual methods. The staining schedule of Jackson*(33)*, Delafield's haematoxylin and safranin and Haidenhain's iron-alum haematoxylin proved the most valuable in histological studies.

The causal fungus was found to enter either through stomata, or directly through the wall of the epidermis at any point. Should the mycelium enter at the juncture between two cells, it passes down between them and later goes directly through the walls of the sub-epidermal tissue. It often happens, however, as shown in Fig. 9, that the mycelium passes directly through the characteristically thin epidermal wall of the colorless motor cells which are adjacent to and partly surrounding the spongy parenchyma. These large cells, according to Artschwager*(4)* have only peripheral protoplasm and a watery sap. The walls and contents of the cells soon turn brown and as the fungus invades the internal tissues, it is seen that the chlorophyll-bearing parenchyma surrounding the chlorophyll-bearing bundle sheath of the vascular bundle is the first to lose its green color and turn brown. Sections through the Burgundy-colored plesionecrotic margin of the spot show the chloroplasts in the chlorophyll-bearing parenchyma to have completely lost their color and the cellular contents to be much broken up and disintegrated into a Burgundy-colored mass. Even after the chloroplasts in the chlorophyll-bearing parenchyma have lost their normal color and turned brown, however, the much larger green plastids found in the almost spherical cells of the chlorophyll-bearing bundle sheath are still pale green. The large xylem vessels and phloem tissues now turn brown and finally all the cells throughout the thickness of the leaf show their contents to be disintegrated and brownish in color. With the death of the cells, the walls collapse and the tissues shrivel up, so that the diameter of the leaf in the center of the holonecrotic zone may be less than one-half that of the healthy leaf.

In controlled inoculation experiments, using only a pure culture of the pathogene, it was found that after such a short period as 24 hours under favorable conditions of temperature and moisture, the mycelium had penetrated into practically every cell of the leaf tissue except those of the vascular bundles. The typical smoky or bronze brown mycelium could be easily traced in its passage between and through the various cells. In its passage through cells, it frequently had a very large diameter (see Fig. 9). It was noted, however, that for the distance of one and sometimes two or more vascular bundles laterally, no mycelium could be found, although the chlorophyll-bearing parenchyma was very pale green and apparently dying from the effects of the fungus.

In field-collected material, however, the cells of the chlorophyll-bearing parenchyma which were pale green in color, just outside of the Burgundy-colored plesionecrotic zone, were found to be frequently invaded by a very fine, hyaline mycelium, distinct from the rather large, smoky thallus of the true parasite. As will be shown later, the fine hyaline mycelium is that of a fungus which is not capable of penetrating healthy leaf tissue, but can only enter the zone of the lesion which has been killed or weakened in advance by the true pathogene.

As in the case of a number of different leaf spots investigated by Cunningham*(22)*, no definite cicatrice is formed about the edge of the lesion.

Transverse sections often show the pycnidia and perithecia of certain saprophytic fungi imbedded in the leaf tissue, both in the holonecrotic as well as plesionecrotic zones. Fig. 10 shows the fruiting bodies of two distinct fungi most frequently encountered, both forms opening to the upper surface. The perithecial form is recognized as that of *Leptosphaeria sacchari* van Breda de Haan and the pycnidial form that of *Phyllosticta sorghina* Sacc. The perithecia of the former fungus were frequently observed to open to both surfaces of the leaf rather than to the upper surface only as recorded by Butler*(13)*.

The Sheath:—Sections made of natural infections and stained with Delafield's haematoxylin, show that the mycelium penetrates directly through the outer epidermis, in many cases at the juncture between cells. After entrance, the fungus behaves much the same as in leaf infections. It passes between and through the cells and in the plesionecrotic zone could be seen to cause the Burgundy discoloration of the cell contents and walls. The parenchyma surrounding the vascular bundles shows the contents of the cells to be much disintegrated. Later, with the death of the cells within the vascular bundles, all the cells throughout the thickness of the sheath are seen to be much shrivelled and collapsed. The thickness of the tissue in the holonecrotic region becomes considerably less than that in the normal sheath.

With artificially controlled infections, it was found as in the case of leaf infections that the fungus kills the cells for some distance in advance of the thallus. This outer zone of damaged cells was also found to be permeated with very fine, hyaline hyphae in field-collected material. The cross-section of straw-colored sheath spots frequently shows the fruiting bodies of *P. sorghina* Sacc. although the perithecia of *Leptosphaeria sacchari* are occasionlly met with.

The Stem:—Thin sections of field-collected material show clearly that the fungus enters directly through the epidermal wall. After entrance, it passes down between and through the cells of the hypodermis, but could not be traced beyond the lignified cortical sheath. The cell walls and contents of the attacked tissues turn bronze brown. At the outer edges of lesions, the presence of a very fine hyaline mycelium was also observed as in the case of leaf and leaf-sheath lesions. The presence of pycnidia of *P. sorghina* Sacc. in stem lesions is also very common.

Signs of the causal organism cannot be detected with the naked eye. With microscopic aid, however, especially after lesions on leaves, leaf-sheaths and stems have been incubated in a damp chamber for a day or two at temperatures between 22-24°C., the typical smoky conidiophores and spores can be seen, usually associated with the discolored plesionecrotic zone. The spores are large, several-celled and slightly curved. Further, by dehydrating and clearing the tissues of lesions, typical much-branched and closely septated, smoky or bronze brown mycelium characteristic of the parasite in culture can be often seen when viewed from the upper surface.

ETIOLOGY

REVIEW OF THE LITERATURE

Van Breda de Haan*(56)* in 1892 was the first investigator to publish the results of study concerning the cause of the ring spot disease. He records two fungi as being associated with the spots—*Leptosphaeria sacchari* and a species of *Dematium* which is regarded as being possibly the conidial form of *Leptosphaeria.* Proof of a genetic connection between these two fungi is not furnished. Forms of the conidial fungus were obtained in culture and inoculation experiments were partly positive and partly negative. Admission is made that perithecia were not always found in spots and also that a perithecium-bearing culture was not secured for inoculation trials. Although the title of van Breda's paper ("Ring spot disease of cane leaves caused by *Leptosphaeria sacchari* n.sp.") indicates that the cause of the disease was established, definite proof of pathogenicity is not furnished.

Wakker and Went*(58)* in their book published in 1898, also claim that the ring spot disease is caused by *Leptosphaeria sacchari* van Breda. They mention having found a species of *Acrothecium* sometimes in the dead spots, undoubtedly the same fungus as noted by van Breda de Haan under the name of *Dematium* sp., but state that this conidial form is not in any way connected with *Leptosphaeria* and produces an entirely different kind of

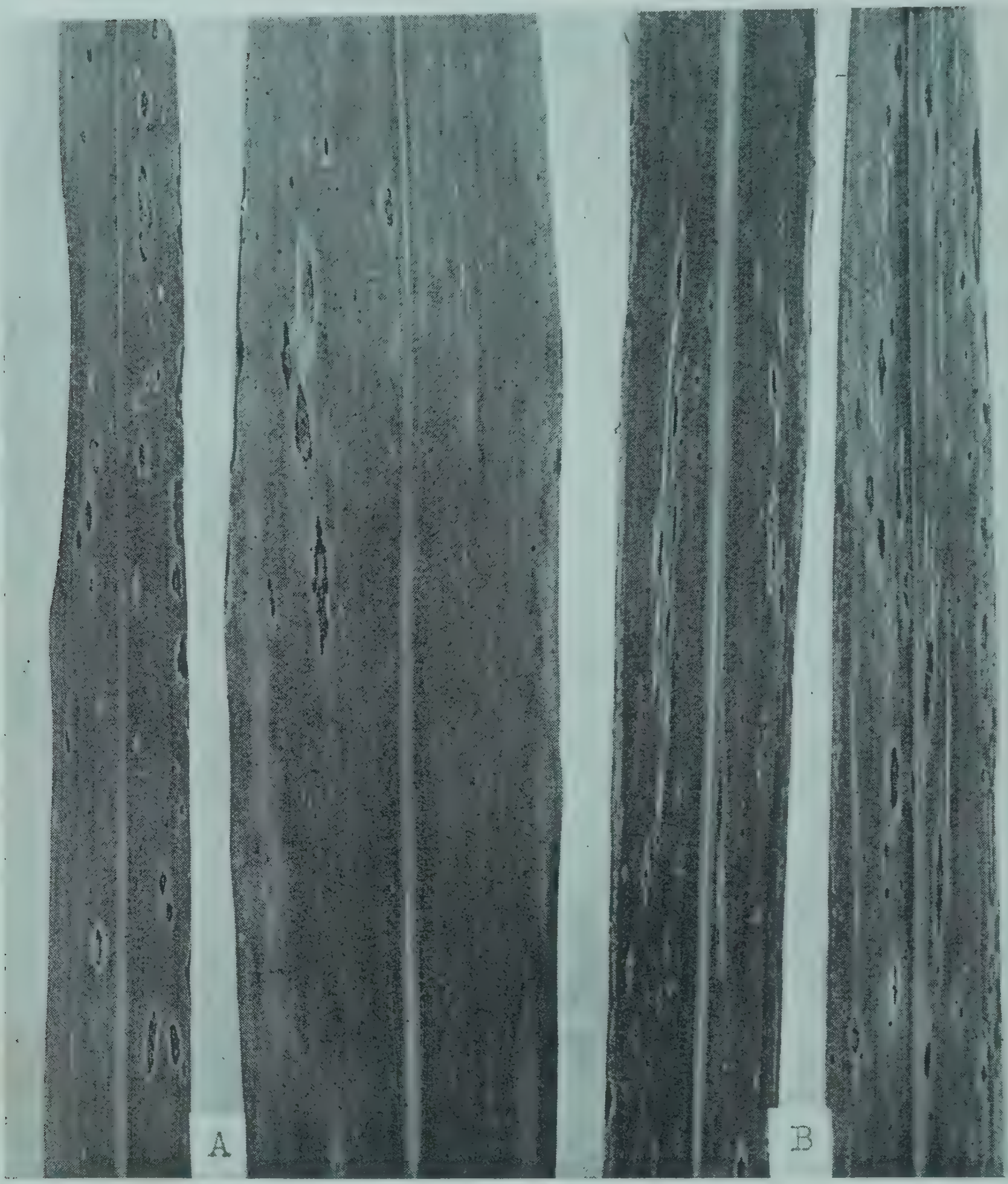

Fig. 2.—Typical eye spot and ring spot lesions on sugarcane x sorghum hybrids. A, F. 31-30 (POJ. 2725 x Kansas Orange sorghum); B, F. 31-8 (POJ. 2725 x Texas Seeded Ribbon sorghum).

mycelium. No conidial form of *Leptosphaeria* was found and, although these authors claim to have grown this fungus in agar cultures, no spores were ever observed for positive identification. In summarizing the results of their observations and experiments, these authors state that although infection experiments had not been performed as yet, it is beyond doubt that the spores of *Leptosphaeria sacchari,* when they come in touch with the young leaves of sugarcane, cause, by penetration of the germ tubes, a local necrosis of the leaves called ring spot disease.

In 1905, Horne*(32)* described the ring spot disease from Cuba under the name of "la enfermedad mancha de ojo," or eye spot disease. He states that the malady is due to *Leptosphaeria sacchari*, but gives no experimental proof of this contention.

In 1906, Butler*(12)* recorded the ring spot disease from Bengal. He described a conidial form which agrees with that of *Dematium* by van Breda de Haan*(56)* and *Acrothecium* by Wakker and Went*(58)*, but made no attempt at classifying the same. Statement is made that this conidial fungus is capable of infecting leaves by entering directly into the cells and that it is the more important form directly concerned in the attack, the *Leptosphaeria* stage being the "resting" form. No proof of the genetic connection between the conidial and perithecial forms is given.

In 1909, Cobb*(17)* in Hawaii also described the ring spot disease as being due to *Leptosphaeria sacchari*, the conidial form being of the same type as described by van Breda de Haan*(56)* and Butler*(12)*.

Later, however, in 1918, Butler*(13)*, after reviewing the work done by other investigators, rather leans toward the conclusion that *Leptosphaeria sacchari* is the true cause of ring spot, the conidial stage previously mentioned as being the chief agent in the spread of the disease being considered to be merely of accidental occurrence on the spots.

Subsequent mention of the ring spot disease in the literature invariably refers to *Leptosphaeria sacchari* as being the cause, a contention obviously having no sound experimental background after weighing the evidence presented by various investigators from the time of the original description of the malady in 1890.

MICROÖRGANISMS FOUND ASSOCIATED WITH THE DISEASE

EXPERIMENTAL PROCEDURE

Typical ring spots were collected in different localities and on different varieties of sugarcane. Portions were imbedded in paraffin for histological study, while other portions were used for free-hand sectioning and the isolation of associated microörganisms. Dried herbarium material was also preserved.

For isolation studies, "Difco" corn meal agar and glucose potato agar were the standard media employed. The usual method of superficial sterilization of the tissue, taken mainly from the outer edge or plesionecrotic zone of diseased spots, by means of alcohol, 1-1,000 mercuric bichloride and thorough washing with sterile distilled water was employed previous to planting such tissue in sterile perti dishes, freshly poured to the nutrient agar. Only an instantaneous immersion of the tissue in the disinfectant was possible, since prolonged treatment invariably resulted in sterile cultures. After isolation of pure cultures by the tissue planting method, monosporous cultures were prepared from these either by the method devised by Keitt*(36)* or Mutch*(45)*. The monosporous cultures were then employed for inoculation and other studies. In order to secure single-spore cultures of *Leptosphaeria sacchari*, typical lesions having the fruiting bodies of this fungus in the holonecrotic zone were cut out and stuck to the cover of the petri dish in an eccentric position by means of a drop of melted nutrient agar. After pouring the plate, the cover was rotated very slowly so that a complete revolution was made in half an hour. By this means, ascospores could be readily isolated and grown in pure culture.

The organisms isolated were grown mainly on corn meal agar and glucose potato agar, although sterilized cane leaves with a few drops of distilled water in the bottom of the tube proved an unusually good medium for propagation and study.

RESULTS OF ISOLATION EXPERIMENTS

From 104 tissue plantings made from leaf spots on the varieties S. C. 12-4, B.417, Otaheite, CP.27-139, Badila, D.74, Ba.11569 and POJ.2725, *Helminthosporium ocellum* was isolated 19 times and it was secured in every batch of material plated. The number of times isolations were successful in the case of various other organisms was as follows: *Phyllosticta sorghina* 59, *Nigrospora* sp. 44, *Leptosphaeria sacchari* 21, *Spondylocladium* sp. 7, *Alternaria* sp. 1, and a yellow motile bacterial organism 1.

Isolations from ring spots on the leaf sheath were made in the case of the varieties POJ.2725, Ba.11569, CP.27-139 and D.74. Twenty-three tissue plantings yielded *Helminthosporium ocellum* 11 times, its presence being noted in each batch, *P. sorghina* 14 times and *Nigrospora* sp. 5 times.

In the case of stem lesions, only the very susceptible varieties B. 417 and D. 74 were used. From 28 tissue plantings, *H. ocellum* was secured from each batch. *P. sorghina* was also isolated from each lot of material studied and appeared to be almost constantly associated with the true pathogene.

An examination of the results of the isolation trials from a great many typical lesions on leaf, leaf-sheath and stem, brought out the fact that *Helminthosporium ocellum* Faris was isolated from every batch of material used for study. *Phyllosticta sorghina* Sacc., *Spondylocladium* sp., *Alternaria* sp., *Nigrospora* sp. and *Leptosphaeria sacchari* van Breda de Haan were also found associated with typical lesions, but *P. sorghina* and *Nigrospora* sp. were most frequently met with.

In certain instances, *H. ocellum* was known to be present on the lesions by microscopic examination, yet the technique used for isolation failed to recover the pathogene, undoubtedly due to the temperature of incubation which favored the activities and rapid growth of the associated organisms, especially *P. sorghina.*

Leptosphaeria sacchari, although frequently associated with the disease on the leaves, was not always present and also was not met with as frequently as *P. sorghina.* Further, it has not been encountered in isolation trials from the stem, whereas *P. sorghina* was very often found on lesions occurring on all parts of the host.

INOCULATION EXPERIMENTS WITH PURE CULTURES

ON SUGARCANE LEAVES

Pure cultures of sugarcane were prepared similar to the method described by Faris*(26)*. Instead of employing cylinders, however, which have a rather small capacity for the development of cane leaves, cuttings previously sterilized in either 1-1,000 mercuric bichloride or calcium hypochlorite solution as used by Wilson*(61)* were transferred without rinsing to the culture jar described herewith. This culture jar consisted of an ordinary desiccator with bell jar fitted to the top instead of the usual cover. The base was filled with soil soaked in Knop's solution and the top of the jar fitted with glass tubing plugged with cotton at the ends to provide for passing fresh filtered air through the culture every two or three days to imitate nearly normal growing atmospheric conditions. The whole culture jar was then sterilized in the autoclave for two hours at 20 pounds steam pressure. After removal of the jar from the sterilizer, the cork and tubing joints were sealed with hot paraffin, while the ground glass joint between the bell jar and desiccator was sealed with vaseline. The transfer of cuttings was made under a hood and the cuttings were not covered with sterile soil, this being found to be entirely unnecessary for good germination and growth. In passing air through the culture jar, two wash bottles were employed filled with 1-1,000 mercuric bichloride solution for the air intake, the jar being connected with an ordinary water pump. In order to make inoculations, the plant culture was removed to the hood, the bell jar removed and the leaves either atomized with spores suspended in sterile distilled water, or pieces of the agar or cane-leaf culture were transferred aseptically to the leaf surfaces. After inoculation, the leaves were finally atomized with sterile distilled water before replacing the bell jar cover. Cultures were grown in the greenhouse with partial shade or near a window of the laboratory, where they could receive direct sunlight during a part of the day.

The cultures of microörganisms used for inoculation were those secured in the isolation trials and included *Helminthosporium ocellum,* which had already been shown to be pathogenic on cane leaves by Faris*(26)* and regarded by him as being the cause of a distinct malady known as eye spot. Monosporous cultures were prepared of *Phyllosticta sorghina* Sacc. by means of the method described by Mutch*(45)*, while the method of Keitt*(36)* was found suitable for preparing similar cultures of *Spondylocladium* sp., *Helminthosporium ocellum* and *Leptospaeria sacchari.* Cultures of the last named fungus were also prepared directly from the leaf by isolating discharged ascospores in petri dishes as previously described. The species of *Nigrospora* was not secured in monosporous culture, although pure cultures were easily secured. Young, vigorous cultures from one to two weeks old were always employed for inoculation.

In all, 145 inoculations of *L. sacchari* were made on the varieties S. C. 12-4, D. 74, B. 417, CP. 27-139 and Otaheite; 21 of *Spondylocladium* sp. on Otaheite and B. 417; 50 of *Nigrospora* sp. on Otaheite and B. 417; 73 of *P. sorghina* on D. 74, B. 417, Otaheite, S. C. 12-4 and CP. 27-139; 22 of the yellow *Bacillus* sp. on B. 417 and Otaheite and 38 of *Alternaria* sp. on D. 74 and CP. 27-139. No positive infections were secured from any of the above. Of 135 inoculations of *H. ocellum* made on D. 74, B. 417, CP. 27-139, Otaheite and S. C. 12-4, however, all proved positive, the incubation period ranging from 14 to 24 hours.

In addition to using portions of agar culture on the leaves, the latter were sprayed with spores of *P. sorghina* and *H. ocellum* in several trials. In all cases, *H. ocellum* gave countless numbers of infections, while *P. sorghina* gave only negative results.

In all inoculation experiments, two control plants were sprayed with sterile distilled water and held under similar conditions to those inoculated. In no instance did any of these control plants become infected.

In numerous cases, *H. ocellum* was recovered in pure culture from artificially reproduced lesions.

ON LEAF SHEATHS AND STEMS

Because of the difficulty of growing sugarcane in pure culture to secure normally developed full-sized leaf sheaths and stems, most of the experiments reported were made with apparently healthy full-sized sheaths and stems of susceptible varieties collected in the field. The sheaths and stems were rinsed in tap and distilled water and placed in glass cylinders 25 cms. long x 50 mms. wide, fitted with rubber corks and previously sterilized with 1-1,000 mercuric bichloride. About an inch of distilled water was placed in the bottom of the cylinder to supply moisture and prevent withering.

After placing selected material in the cylinders, it was incubated for 4 days prior to inoculation in order to detect the development of any incipient spots. Those developing lesions on incubation were discarded. Two control sheaths and stems were always held without inoculation throughout each trial.

Of 45 inoculations of *P. sorghina* on the leaf-sheaths of CP. 27-139, D. 74 and Otaheite and 33 on the stems of the former two varieties, none proved positive. Similarly, 23 inoculations of *Nigrospora* sp. on the leaf sheaths of CP. 27-139 and D. 74; 19 of *Alternaria* sp. on leaf-sheaths of Otaheite and B. 417 and 15 of the same fungus on the stems of D. 74 and CP. 27-139, all proved negative. On the other hand, 38 inoculations of *H. ocellum* on leaf sheaths of CP. 27-139 and D. 74 and 33 on stems of CP. 27-139, D. 74 and Ba. 11569, all proved positive. The incubation period of *H. ocellum* on the sheaths varied from 18 to 36 hours and on stems 49 to 96 hours.

All of the trials recorded above were made with field collected material. However, two pure culture plants, such as were used for leaf inoculations, were employed for similar trials on the sheath. In all, 20 inoculations of the green sheaths were made with *H. ocellum*. All proved positive in three days.

Artificially produced sheath and stem lesions by *H. ocellum* were used for re-isolation of the pathogene. The fungus was recovered in numerous instances. The control sheaths and stems also remained healthy throughout the period of the trials.

It became very clear as a result of numerous inoculation experiments under controlled conditions that of all the organisms isolated, only *Helminthosporium ocellum* was pathogenic. The type of lesion formed by this organism on the leaves; however, was typical of that of eye spot which had been well described and figured by Faris*(26)*. The problem presented, therefore, was how to account for the characteristic ring spot lesions on leaves, sheaths and stems. The results naturally suggested that one or more of the accompanying saprophytic organisms might be responsible for the change of eye spot lesions to those of typical ring spots. It had been established as a fundamental fact that ring spot lesions always gave rise to more than one organism in isolation trials, even when the plesionecrotic zone was superficially sterilized and plated out. Among the organisms accompanying *H. ocellum* in ring spots, *Phyllosticta sorghina*, *Nigrospora* and *Leptosphaeria sacchari* were outstanding in the number of times they were isolated.

Before making any inoculations with known mixtures, all the isolated fungi were first studied physiologically in pairs in plate cultures so as to gain information as to association effects.

The results of these trials, reported elsewhere in this paper, indicated that *P. sorghina* and *L. sacchari* were both unaffected in their associations with *H. ocellum* in culture, while *Nigrospora* sp. and *H. ocellum* were mutually antagonistic. Thus inoculations were first made with mixed cultures of *H. ocellum* and either *P. sorghina* or *L. sacchari.*

INOCULATION EXPERIMENTS WITH CERTAIN MIXED CULTURES

These experiments were carried out both with field collected leaves, sheaths and stems in sterilized glass cylinders as already described, incubating the material for 4 days in each before inoculation, and with leaves only, using pure culture methods for growing the host. In all trials, inoculations were made in duplicate series, one series with *H. ocellum* alone and the other with the known mixture. Two controls without inoculation were kept in each series.

Table I gives the results of these inoculation experiments using known mixtures of isolated fungi.

TABLE I.—SUMMARY OF RESULTS OF INOCULATION EXPERIMENTS WITH KNOWN MIXTURES OF ISOLATED FUNGI COMPARED WITH H. OCELLUM ALONE.

Mixture of Organisms.	Part of Host.	Variety Used.	No. of Inoculations.	Results Compared with *H. ocellum* Alone.
A—*H. ocellum* + *P. sorghina.*	Leaf	D. 74	35	Lesions enlarged very rapidly, forming large, irregular-shaped blotches with ring spot appearance after a week. The *H. ocellum* lesions were typical of eye spots and were relatively small.
B—*H. ocellum* + *L. sacchari.*	Leaf	D. 74	22	Practically no difference could be noted in the mixed cultures as compared with *H. ocellum* alone.
C—*H. ocellum* + *P. sorghina.*	Sheath	CP. 27-139.	28	Results essentially the same as with D. 74 leaves in (A).
D—*H. ocellum* + *L. sacchari.*	Sheath	CP. 27-139.	30	Results essentially the same as with D. 74 leaves in (B).
E—*H. ocellum* + *P. sorghina.*	Stem	CP. 27-139.	17	Lesions were significantly larger and soon developed aluminum colored centers.
F—*H. ocellum* + *L. sacchari.*	Stem	CP. 27-139.	20	No significant difference could be observed between the two series.

DISCUSSION OF RESULTS OF INOCULATION EXPERIMENTS ON SUGARCANE

An examination of the results shows clearly that *H. ocellum*, while it was the only organism isolated from ring spots capable of producing infections on leaves, leaf-sheaths and stems of susceptible varieties, yet by itself it failed to form lesions exhibiting the complete range of morphological symptoms characteristic of the disease as it occurs in the field and as commonly described in the literature. On leaves, the lesions formed by *H. ocellum* were identical with those of eye spot.

Of the organisms which were mutually agreeable with *H. ocellum* in culture, only *Phyllosticta sorghina* was found to be effective in rapidly enlarging the eye spot lesions on various parts of the host and changing their appearance to those of ring spots. Fig. 3 shows the typical difference occurring in parallel inoculations on leaves of Otaheite with *H. ocellum* alone (A) and mixed with *P. sorghina* (B), even after the brief period of only five days.

ISOLATION AND INOCULATION EXPERIMENTS WITH HOSTS OTHER THAN SUGARCANE

Although repeated attempts at the isolation of *H. ocellum* from typical ring-spot-like lesions on *Holcus sorghum, Panicum dichotomiflorum, Panicum maximum* and *Panicum* sp. had failed, the writer determined to try inoculations of this sugarcane pathogene on *Holcus sorghum* and also on a number of intergeneric hybrids between *Holcus* and *Saccharum* which he had produced, since a number of these latter had shown typical eye spot and ring spot lesions as exhibited in Fig. 2, and *H. ocellum* had been isolated several times from them. The importance of these studies is obvious when considered in the light of extended host range and the inheritance of resistance or susceptibility to the disease from sorghum and sugarcane respectively in the intergeneric hybrids.

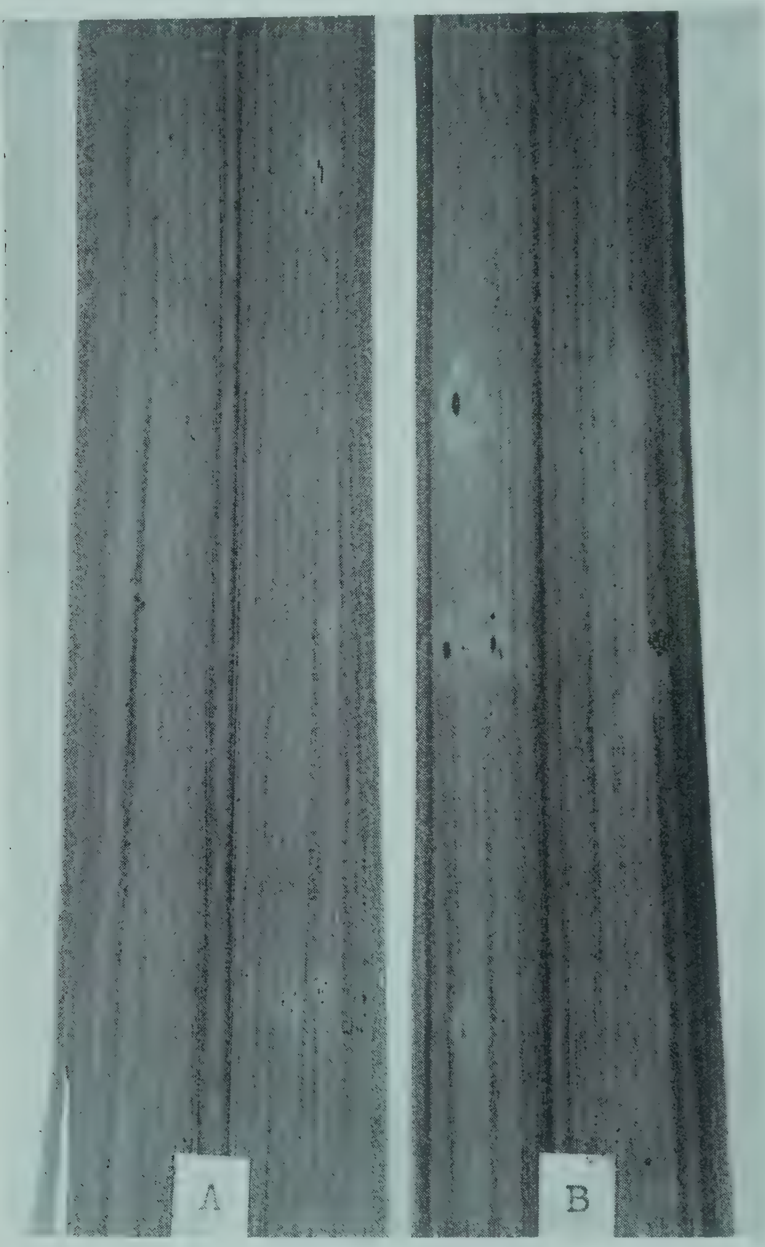

Fig. 3.—A, leaf of Otaheite cane inoculated with *Helminthosporium ocellum* alone, after five days at room temperature (28-30°C.). B, leaf of Otaheite cane inoculated with *H. ocellum* and *Phyllosticta sorghina*, after five days. Both A and B were inoculated at the same time and held under identical conditions.

INOCULATIONS ON SORGHUM LEAVES

These experiments were carried out with healthy field-collected leaves of the varieties Texas Seeded Ribbon and Kansas Orange, using sterilized glass cylinders as already described and incubating the leaves for 4 days prior to inoculation. Also, an additional series of trials were made with young sorghum plants grown under aseptic conditions from seed superficially sterilized with calcium hypochlorite and reared in culture jars used for sugarcane. Inoculations were made both by atomizing spores of *H. ocellum* and using portions of agar cultures on the leaves. Two control jars with young plants and cylinders with leaves were used in each case for comparison, the same being sprayed with sterile distilled water instead.

Results

Repeated trials with both varieties, on mature leaves and those of young plants, failed to show any infections even after two weeks.

INOCULATIONS ON LEAVES OF CERTAIN *Saccharum x Holcus* HYBRIDS WITH *H. ocellum*

These trials were conducted only with fully grown leaves of plants, using sterile cylinders as in the case of sugarcane and sorghum. The hybrids F. 31-8, F. 31-29 and F. 31-30 were used, the first mentioned being the cross POJ. 2725 x Texas Seeded Ribbon and the latter two POJ. 2725 x Kansas Orange. That these are genuine hybrids is shown by the marked sorghum characters exhibited. Two controls were used in each case and the experiments were repeated twice.

Results

In every instance numerous infections were secured after 24 hours. Reisolation of the pathogene was readily accomplished in several instances. The control leaves showed no symptoms of infection after 10 days.

DISCUSSION OF RESULTS

While the two varieties of *Holcus sorghum,* Texas Seeded Ribbon and Kansas Orange, have shown immunity to *H. ocellum* under the conditions of the experiments, it is not known whether other varieties would react similarly to this pathogene.

That several intergeneric hybrids of *Saccharum* x *Holcus* should prove susceptible to the disease is of considerable interest, especially since both male parents (sorghum) were immune. However, only hybrids found susceptible under field conditions were used in the inoculation trials in order to definitely establish the pathogenicity of the sugarcane fungus. Of equal significance is the fact that certain promising hybrids from an agricultural and commercial standpoint, e. g. F. 31-61 (POJ. 2725 x Kansas Orange), have so far shown high resistance to the disease after field exposure on Okeechobee muck soil for one year. Although a very large number of hybrids have not been under experimental observation, it has definitely been established, nevertheless, that the above intergeneric hybridization work is of value from the standpoint of breeding for resistance to the disease.

THE PATHOGENE

NAMES, HISTORY AND CLASSIFICATION

The pathogene belongs to the group Fungi Imperfecti, Order Moniliales, Family Dematiaceae, Section Phragmosporae and Genus *Helminthosporium.* Although the fungus has been grown on a wide range of culture media and kept under observation for more than two years, a perfect stage has never been observed.

According to Faris*(26)*, who in 1928 gave the first description of the species into which the fungus falls, the spore and conidiophore measurements agree fairly well with those given for *Cercospora sacchari* by van Breda de Haan*(56)*. He pointed out that although Johnston and Stevenson*(35)* in 1917 made *Helminthosporium sacchari* Butler a synonym of *Cercospora sacchari* van Breda de Haan, the spore and conidiophore measurements of the two fungi did not agree and further, no comparative study of the two organisms was made to properly settle the question. The same author also proposed the name *Helminthosporium ocellum* n. sp. for the fungus and showed that it was distinct from *H. sacchari* Butler and *H. stenospilum* Drechsler.

The fungus which the writer has found as being the primary cause of sugarcane eye spot as well as ring spot in Florida was studied in monosporous culture for the purpose of identification and comparison with the morphological description by Faris. Conidiophore and spore measurements were made from typical lesions artificially produced on cane leaves. The conidiophores varied in length from 70.3 to 277.5 *y* (average of 30—158.4 *y*); the width varied from 3.7 to 9.25 *y* (average 6.3 *y*) and there were from 3 to 8 septa (average 5.7). The spores varied in length from 24.1 to 92.5 *y* (100 measurements average 58.7 *y*); width varied from 11.1 to 16.7 *y* (average 14.0 *y*) and there were from 3 to 9 septa (average 6.7). The color of the spores and conidiophores and the marked bulbous base of the conidiophores, etc., were identical with that found by Faris.

Even though distinct differences in average conidiophore and spore measurements occur as well as color of spores in the three well defined species of *Helminthosporium* on sugarcane, adequate comparative information on the physiology of the various species is lacking. For the purpose of this paper, only the physiology of *H. ocellum* has been undertaken as a basis for further comparative data on other species and to definitely establish additional characteristics of the pathogene as an aid in proper classification.

LIFE HISTORY

1. Inoculation:—The entire life cycle of *H. ocellum* is spent in the tissues of the host which is attacked, as far as can be determined. The disease of the ring spot type has been found to appear on the young leaves about two or three months after the cane germinated, either as plant or ratoon crop. Such young cane may occur in the usual scheme of planting and harvesting at present, anywhere from December to June in Florida. As a rule, however, serious outbreaks do not occur until the advent of cool weather in October, November and December, accompanied by very heavy dews, which frequently remain on the leaves until noon in the Everglades region during this period. At this time, the disease is especially abundant on the outer whorl of leaves, the leaf sheaths and stems of susceptible varieties. Badly attacked standing cane adjoining young plant or ratoon fields are common sources of primary infection. However, the fact that the fungus occurs on lesions on the stalk and also that seed pieces having lesions when planted in isolation or even germinated under a bell jar culture without sterilization will frequently show leaf infections, is evidence that the seed piece is a common source of inoculum and undoubtedly has been instrumental in carrying the disease from one country to another in the past.

In the case of ratoon cane, the bed of trash in the field consisting largely of dead leaves, leaf sheaths, tops left by the cutters and even dead and dying stalks, is a very frequent source of inoculum. Dead leaves, sheaths and portions of decaying stalks having eye spot or ring spot lesions, on being placed in a damp chamber and kept at temperatures between 22°C. and 25°C. will often show conidiophores and conidia of the pathogene on the surface after 24 to 48 hours.

It is evident that spores borne on the long conidiophores are easily blown by the wind and carried by splashing rain to other sugarcane leaves, sheaths and stems.

Whether or not insects are instrumental in carrying spores from one part of the host to another or from one plant to another, has not been definitely determined. Dead leaves and even living seed pieces without surface sterilization, when placed in a damp chamber, soon show large numbers of mites associated with them. Evidence that these animals travel in nature from decaying material to the living parts of the host is available from numerous observations of germinating seed pieces, when the green leaves have frequently been observed to have mites on them.

Primary infections, once started on the living host, produce abundant conidiophores and conidia for secondary infections from the developing lesions. These spores can readily be blown by the wind or washed by driving rain to other leaves, leaf sheaths and stems, or may even be accidentally carried by insects crawling over the spore-bearing lesions.

As a result of numerous inoculations, it was found that infection took place just as readily whether the inoculum was placed on the upper or lower surface of leaves. One of the most essential conditions for infection, however, was found to be the presence of free moisture on the surface.

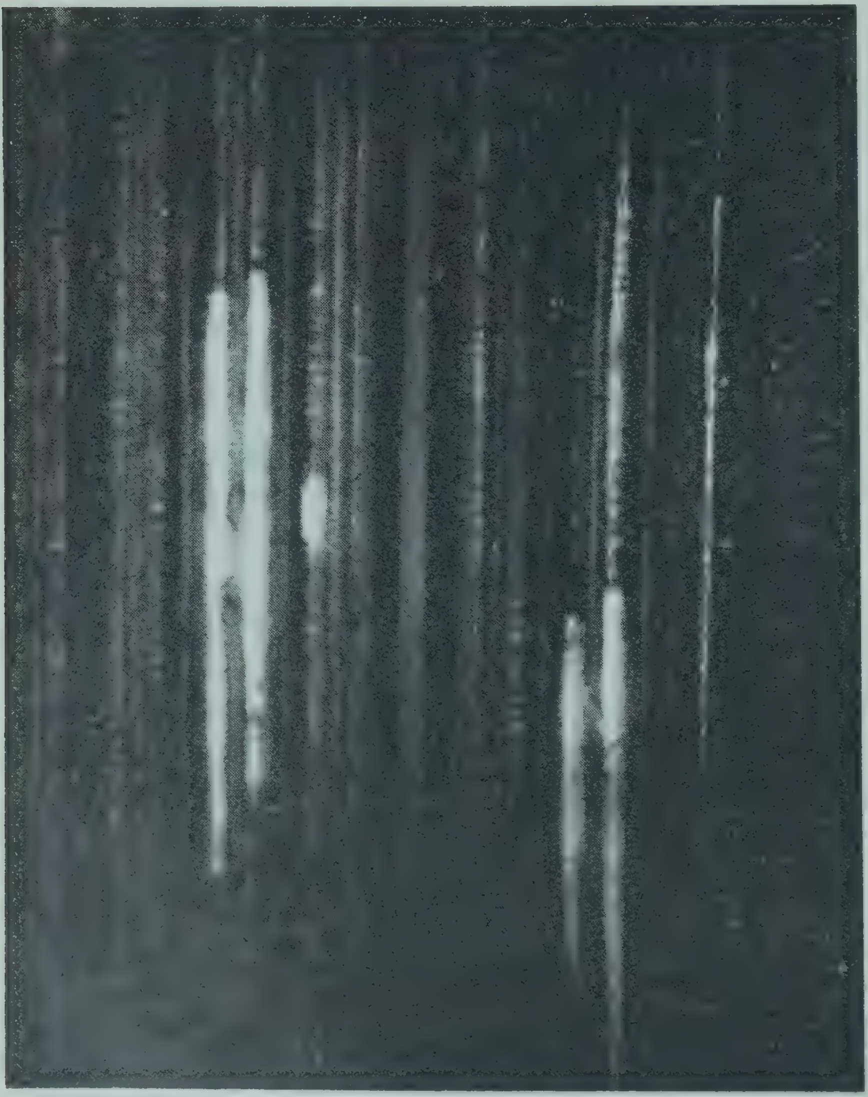

Fig. 4.—Portion of Otaheite leaf 14 hours after inoculation with spores of *H. ocellum*.

2. Incubation:—The period of incubation was found to vary from about 14 hours to two days, depending upon temperature and moisture conditions and the age of the leaf. On the whole, young leaves were infected slightly sooner than physiologically mature ones. Fig. 4 shows typical lesions on young leaves after 14 hours.

The germination of spores is shown in Fig. 7. Under suitable temperature and moisture conditions, germ tubes are produced in about two hours in distilled water, but in 1% sucrose solution, they appear much sooner. Spores usually germinate from both ends, but occasionally they put out a tube from one end only. The anastomosing of germ tubes was commonly seen.

Penetration was studied in the case of several varieties, including Otaheite, D. 74 and CP. 27-139. Spores from a young agar culture were placed on unwounded leaves, leaf sheaths and stems, incubated for various periods (at room temperature) ranging from 14 hours to several days. Free-hand cross sections were then made through the infection courts or thin sections were cut parallel to the surface, mounted and examined direct with a compound microscope. It was clearly seen in the case of leaf material that the fungus can enter directly through the walls of the epidermis as shown in Fig. 9 or it may enter through stomates. Passage through the wall of a short epidermal cell is shown in Fig. 8. After entrance, the mycelium passes inter and intracellularly. Fig. 9 shows the thick mycelium passing directly through certain cells. The intercellular mycelium is often much smaller in diameter than that passing through cells. The mode of entrance into leaf sheaths and stems was found to be essentially the same as in the case of the leaf. In its passage through the epidermis of the motor cell of the leaf shown in Fig. 9, it is seen that the thickness of the mycelium is practically unaltered in the cuticle layer. On reaching the primary cell wall beneath, however, the growing point becomes enlarged and a characteristic peg-like strand passes through the wall as recorded in the case of pathogenes which are regarded as effecting passage through cell walls at least partly through mechanical pressure.

3. Infection:—The infection stage on the various parts of the host lasts throughout the age of the part affected. In the case of leaves and sheaths, spots of the eye spot or ring spot type may exist for two months or longer, depending on the age of the part at the time of infection and the rate of growth of the host as influenced largely by the period of the year. With the shedding of leaves and sheaths, the fungus may live saprophytically on the decaying tissues. Stem infections persist until the cane is harvested, which may occupy a period of more than a year from the time of the initial infection.

Under favorable conditions, fruiting bodies may appear in a few days after the lesions are formed and may continue to form as long as the lesion exists and food is available.

The infection stage becomes evident with the formation of a peculiar watery appearance of the infection courts. Sections show that the cuticle as well as cell walls of sub-epidermal tissue are colored a characteristic pink in the early stages of infection. Later, these walls become Burgundy or bronze brown in color.

It is evident that the fungus damages the cells in advance because it was impossible to find the mycelium of the parasite in the pale green cells of the chlorophyll parenchyma adjoining the Burgundy colored plesionecrotic zone with its dying and dead cells containing mycelium.

The pink walls of the epidermis and other cells injured in advance by the parasite are undoubtedly weakened so that *P. sorghina,* the frequently associated saprophyte, can readily penetrate and aid in the destruction. Mixed culture inoculations show clearly that such weakened tissues in advance of the true parasite have very fine hyphae passing into and through the cells. In the mixture referred to, the other fungus was *Phyllosticta sorghina.* Thus the histological phenomena appearing in the case of natural lesions commonly called ring spots, can be reproduced at will by using mixed cultures containing *H. ocellum* and *P. sorghina.* Owing to the importance of the latter fungus in changing typical eye spots during the infection stage to ring spots, it was thought desirable to determine the classification and identity of the fungus, its general physiological characters and the host range.

Because of the frequent occurrence of *L. sacchari* in the late infection stage and the opportunity afforded during the course of the work for life history and certain physiological studies on this fungus, interesting data on it are recorded in other sections.

TWO ASSOCIATED SAPROPHYTES

NAMES, HISTORY, LIFE HISTORY AND CLASSIFICATION

1. *Phyllosticta sorghina:*—This fungus saprophyte belongs to the Group Fungi Imperfecti, Order Sphaeropsidales, Family Sphaerioidaceae, Section Hyalosporae.

Although the fungus has been grown on a wide range of culture media and kept under observation for two years, a perfect stage has never been observed.

The first description of the species into which the fungus falls was by Saccardo*(49)* in 1878, although the complete volume did not appear until the following year. The first description was from *Sorghum vulgaris,* but the same author*(50)* later mentioned its occurrence on *Sorgho halepensi.* Allescher*(2)* also gave a description of the organism, but showed the spore measurements to be slightly different from those of Saccardo*(49)*.

Not realizing that Saccardo*(49)* had already described the same organism from *Sorghum* spp. several other workers have described the fungus under different specific names as shown by comparative cultural studies made by the writer. Spegazzini*(52)* in 1896, published a description of *Phyllosticta sacchari* Speg. (n. sp.) occurring on the leaves of sugarcane which falls readily under the description of *P. sorghina* Sacc.

Young*(62)* in 1915 definitely records the presence of *Phyllosticta sacchari* Speg. on *Saccharum* in Porto Rico and also described *Phyllosticta panici,* sp. nov. from the leaves of *Panicum maximum* in the same island. Comparative cultural studies by the writer have definitely shown that these organisms are identical with *P. sorghina* Sacc.

Caum*(14)* in 1921 described *Phyllosticta hawaiiensis* from the sheath and stem of *Saccharum officinarum* in Hawaii. As already mentioned in this paper, the same organism occurs on leaf, leaf sheath and stem of sugarcane in Florida associated with the parasite *Helminthosporium ocellum* Faris and is properly to be referred to *Phyllosticta sorghina* Sacc.

Ellis and Everhart*(25)*, in recording the species of *Phyllosticta* in North America up to August, 1900, do not mention any species occurring on *Saccharum, Zea, Sorghum* or *Panicum.* In 1926, however, Stevenson*(53)* records the occurrence of *P. sorghina* Sacc. on *Holcus effusum, H. halepenis* and *H. sorghum* in Russia, India, Italy, Portugal and Argentina. He also mentions that the fungus has been reported from Texas, but the exact species on which it occurred, or whether it was considered parasitic or saprophytic is not mentioned. However, this is the first record which the writer has found of the occurrence of this organism on the North American continent.

Judging from the small variations occurring in the enormous number of species of *Phyllosticta* which have been described, it would appear to be impossible to place certain species definitely on the basis of the morphological characters alone. The neces-

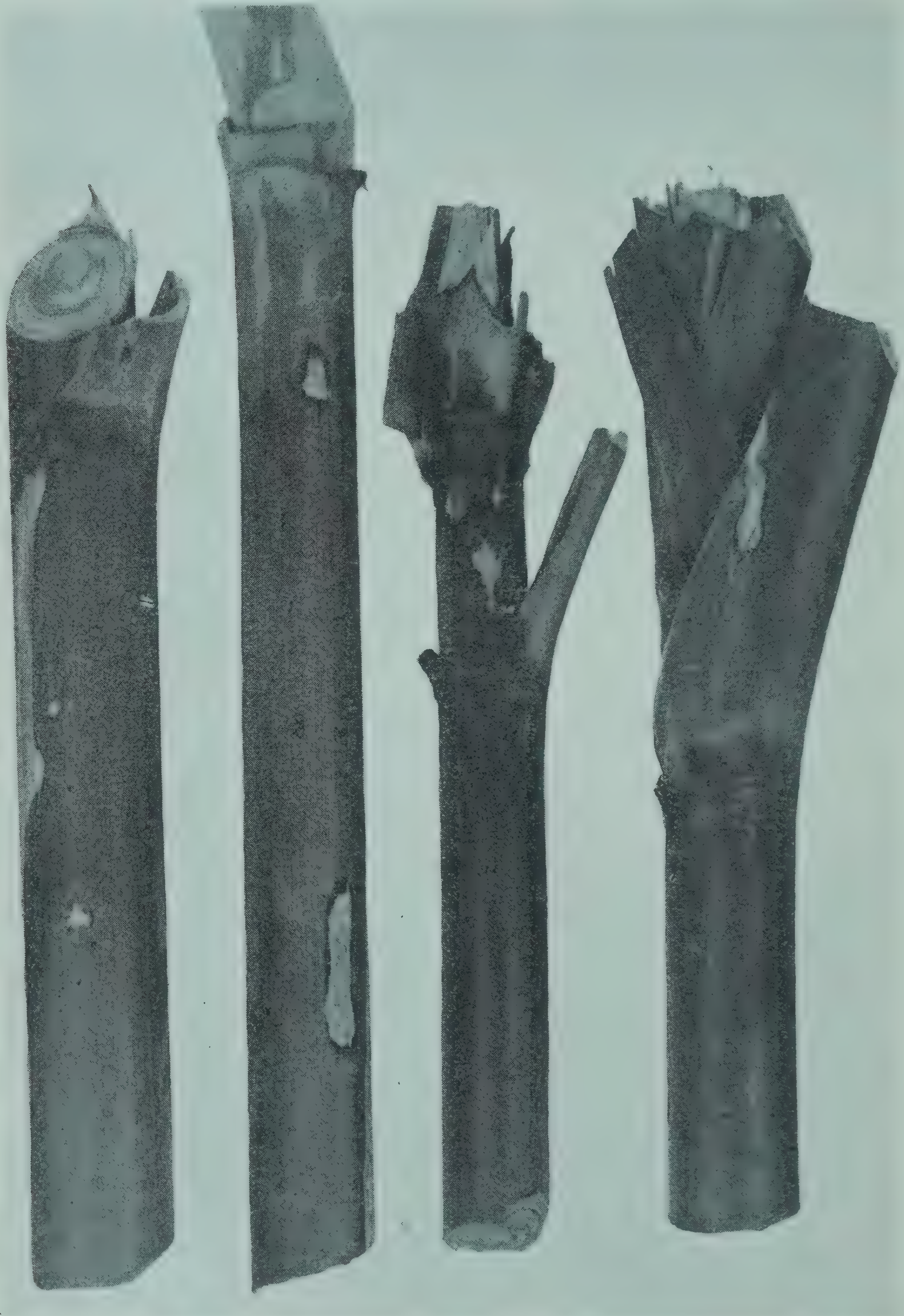

Fig. 5.—Ring spot and eye spot lesions on sheath and lower portions of leaf blade of D. 74 sugarcane.

sity, therefore, for detailed knowledge of the physiology of the various species has encouraged the writer to investigate this phase more fully with respect to *P. sorghina* so as to furnish a proper basis for classification within the genus and also give some information concerning its activities in changing eye spot lesions to ring spots.

Figures 10, 11 and 12 show typical pycnidia of *P. sorghina* on the upper surface of ring spot lesions of sugarcane in Florida. Pycnidia are found to vary from 44 to 147 *y* in diameter and spores 3.4-6.7 x 1.7-3.4 *y*.

As shown in Fig. 16, the spores on being placed in water or weak nutrient solution, swell considerably and may reproduce by budding in a yeast-like fashion. Germ tubes form from one or both ends and anastomosing is frequent with the young mycelium. On account of the swelling of spores in liquids and the formation of secondary bud spores, considerable variation in size is likely to occur and may account for the variations noted by Saccardo*(49)* and Allescher*(2)* already mentioned in another section.

The same *P. sorghina* was isolated many times from apparent ring spots occurring on *Holcus sorghum, Panicum dichotomiflorum, Panicum maximum* and *Panicum* sp. (B.P.I. No. 48154) in Florida. Inoculation experiments, however, showed that this organism is not parasitic on these hosts, but apparently occupies a similar role to these diseases as it does to the ring spot of sugarcane.

Comparative cultural and morphological characteristics on different media show clearly that the fungus isolated from the above-mentioned hosts is identical.

2. *Leptosphaeria sacchari:*—This fungus saprophyte has already been classified and described by van Breda de Haan*(56)* in 1892 on the basis of the perfect stage among the Ascomycetes. No proof of a conidial or imperfect stage of this fungus has been furnished by any previous investigator. Wakker and Went*(58)* mention that when grown in agar agar culture, no spores of any kind could be observed.

Tissue plantings by the writer from lesions having *Leptosphaeria sacchari*, and single-spore isolations from perithecia by the method previously described, gave identical cultures. On glucose potato agar at room temperature, growth is very slow, the colonies never completely covering the surface and always becoming much elevated. The consistency is leathery and the edge of the colony a burnt umber in color, while the center is much darker. These colonies have in all cases produced on agar media abundant pycnidia of a species of *Phyllosticta* (see Fig. 17) having very similar shape, size and appearance of perithecia of *L. sacchari* on the surface of ring spot lesions as shown in Fig. 13.

When freshly isolated ascospores were grown on sterile cane leaves, the perfect *Leptosphaeria* stage was secured during the first two months, but after this period, continued transfer to agar or cane leaf cultures yielded only the *Phyllosticta* stage. Proof that the two stages are connected genetically is furnished by the fact that cultures secured from single ascospores of the *Leptosphaeria* stage or pycnospores of the *Phyllosticta* stage yielded identical cultures and also because single-spore ascospore cultures yielded the perfect stage at first in cane leaves when first isolated and later gave only the *Phyllosticta* stage.

The *Phyllosticta* stage agrees well with the description of *P. saccharicola* by Hennings*(31)* on the leaves of sugarcane. That some confusion exists with regard to this conidial stage is evident from the observations of Johnston and Stevenson*(35)*. These authors describe what is apparently the same fungus under the title of *P. sacchari* Speg. but correctly state that it is probably not the same as the latter fungus, which, according to the description by Spegazzini*(52)* has spores less than half the length of *P. saccharicola* and should properly be referred to *P. sorghina* Sacc., in the opinion of the writer.

The germination of spores and anastomosing of germ tubes (from the *Phyllosticta* stage) are shown in Fig. 15. Culturally, this fungus is very distinct from *P. sorghina* and temperature relations to growth in culture also reveal very significant differences as illustrated in Fig. 21.

VARIETAL SUSCEPTIBILITY

Because of the fact that the etiology of the ring spot disease had not been properly understood hitherto, only varieties which became accidentally infected with *Leptosphaeria sacchari* as a saprophyte following the true causal organism, were considered in susceptibility studies. It is obvious that accurate information on varietal susceptibility can only be referred to the records of susceptibility to *Helminthosporium ocellum* Faris which has now been shown to be the cause of the primary stage of ring spot, but which is known from the literature as the primary cause of eye spot. The formation of the ring spot stage is considered to be dependent mainly on *Phyllosticta sorghina* Sacc., which may be followed by *Leptosphaeria sacchari* and other saprophytes.

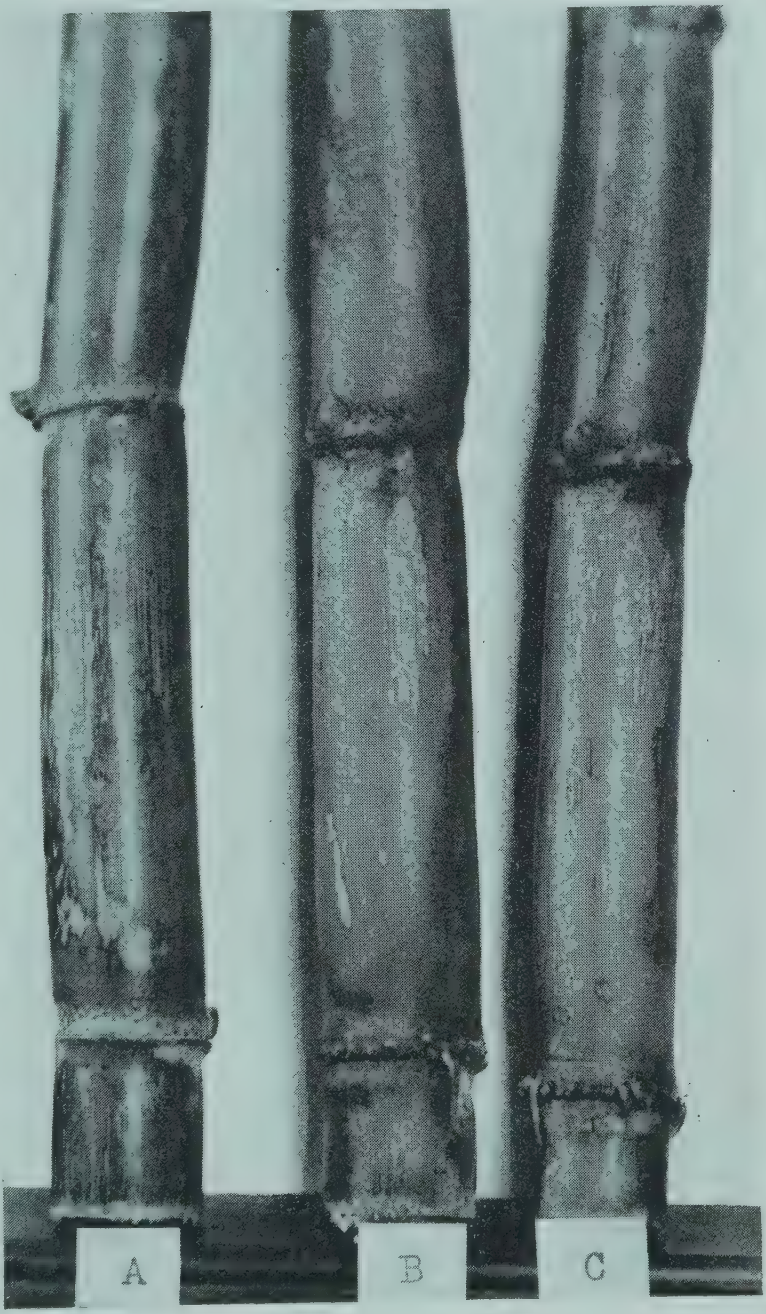

Fig. 6.—Ring spot and eye spot lesions on stems of three varieties of cane—A, B. 417; B, Ba. 11569; C, D. 74.

Faris*(26)* has collected a large amount of valuable data on varietal susceptibility in Cuba and other tropical countries. The writer has not had an opportunity to study comparatively all the varieties investigated by Faris, but nevertheless information collected for a period of nearly three years, covering several sections of Florida having different climatic and soil conditions, may prove of value to cane breeders and commercial cane growers in the sub-tropics. Table II gives the results of combined observations from varietal plots established at Clewiston, Lake Harbor, Belle Glade, Homestead and Lake Alfred. Observations on plots established at Gainesville and Quincy proved unsuitable for these comparative studies, owing partly to the prevailing drought which occurred in these areas during the growing seasons when observations were made.

TABLE II.—COMPARATIVE SUSCEPTIBILITY OF VARIOUS SUGARCANE VARIETIES TO RING SPOT (AND EYE SPOT) DUE TO *H. ocellum* FARIS.

Very Susceptible Varieties*	Varieties Susceptible But Only Moderately Damaged	Highly Resistant Varieties
Otaheite	S. C. 12-4	Badila
Louisiana Purple	POJ. 2714	POJ. 213
Louisiana Striped	POJ. 2725	Co. 213
Cavengire Rayada	CP. 27-139†	Co. 214
Ba. 11569.	POJ. 2883	Co. 281
B. 417.	POJ. 36-M	Co. 290
B. H. 10-12	POJ. 36	CP. 807
L. 511		CP. 27-108
D. 74		Uba
D. 95		Chunnee
POJ. 2878		U. S. 1694
POJ. 100		F. 29-416
F. 29-382		F. 29-7
H. 109		
Crystalina		

*Ba, B and BH canes refer to those bred in Barbados, while those with the insignium D, H and S. C. refer to designations given canes in Demerara, Hawaii and Saint Croix, respectively.

†This variety, after extensive tests, proved to be relatively so very resistant to the disease (as well as other diseases) on "sawgrass" and "willow" lands in the Everglades that it was rapidly extended in 1933 and now occupies about 1,000 acres of commercial plantings.

THE PHYSIOLOGY OF HELMINTHOSPORIUM OCELLUM AND ITS ASSOCIATED SAPROPHYTE, PHYLLOSTICTA SORGHINA

SOURCES OF ENERGY FOR GROWTH

Only single-spore strains of *H. ocellum* and *P. sorghina* were employed in these studies.

In the case of the parasite, *H. ocellum*, information on the physiology with regard to this phase of its nutrition is essential to a proper understanding of its activities within the host tissues. Further, as a basis for comparison with other species of the same genus affecting sugarcane, the data would serve to distinguish these forms more definitely.

Because of the very intimate association of *P. sorghina* with the causal organism, the physiology of this saprophyte seemed particularly desirable from the standpoint of having a better understanding of its activities in making use of substances within the host tissues which have previously been damaged by *H. ocellum*. A comparison could also be made of the biological activities of the two organisms and perhaps some evidence secured of the nature of mutual relationships existing between them. In addition, the data would furnish an adequate basis for comparing species or strains of *Phyllosticta* morphologically identical, but probably very distinct in their physiological characters.

TABLE III.—GROWTH OF *H. ocellum* AND *P. sorghina* (CANE LEAF STRAINS) COMPARATIVELY ON A MINERAL NUTRIENT SOLUTION WITH DIFFERENT SOURCES OF CARBON. (AFTER 10 DAYS AT 28-30°C.).

Carbon Source	Concentration	Average dry weight in mgs. of mycelium from 50 cc. culture.	
		H. ocellum	*P. sorghina*
Monosaccharoses			
Fructose	2%	152.0	136.0
Xylose	2%	136.0	167.0
d-Galactose	2%	111.0	329.5
Glucose	2%	109.5	215.5
d-Mannose	2%	101.5	140.5
Arabinose	2%	26.5	63.0
Rhamnose	2%	10.0	32.5
Inosite	0.45%	5.0	
Inosite	2%		141.0
Disaccharoses			
Sucrose	2%	115.0	189.0
Maltose	2%	100.0	255.0
Lactose	2%	69.5	153.5
Trisaccharoses			
Raffinose	0.265%	51.5	
Raffinose	2%		371.5
Polysaccharoses			
Dextrine (white)	2%	161.0	228.5
Starch	2%	113.5	321.5
Dextrine (yel.)	2%	72.0	131.5
Inulin	2%	71.5	149.0
Gum arabic	2%	30.5	50.5
Cellulose	2%	Good growth	Good growth
Primary Alcohol			
Ethyl alcohol	0.5% by vol.	10.5	69.0
Tri-Acid Alcohol			
Glycerine	2%	1.5	197.0
Hex-Acid Alcohols			
Mannite	2%	10.0	147.5
Dulcite	0.254%	0.5	
Dulcite	2%		11.0
Sorbite	2%		6.0
Organic Acids			
Citric acid	0.5%	0.0	2.0
Tartaric acid	0.5 and 0.01%	0.0	0.0
Oxalic acid	0.5 and 0.01%	0.0	0.0
Acetic acid	0.5 and 0.01% by vol.	0.0	0.0
Tannic acid	0.5 and 0.01%	0.0	0.0
Formic acid	0.5 and 0.01% by vol.	0.0	0.0
Salts of Organic Acids			
Ammonium lactate	2%	4.5	
Sodium asparaginate	2%	2.0	28.0
Amyl acetate	2% by vol.	0.0	7.0
Proteins and their derivatives, Oils, etc.			
Pectin	2%	232.0	264.0
Peptone	2%	158.5	211.0
Gelatin	2%	108.5	152.0
Olive oil	2% by vol.	60.5	255.0
Casein	2%	Good growth	Good growth
Blood fibrin	2%	Good growth	Good growth

The fungi were grown on White's modified Richard's solution*(60)* with varying sources of carbon, mostly in a 2% concentration. Growth was measured where possible by dry weight determinations made by filtering the cultures after growth for 10 days at room temperature (28-30°C.) in diffuse light, into previously prepared and weighed Gooch crucibles and then drying in an oven at 105°C. to constant weight. Notes were also made of any special characteristics of the various cultures.

The comparative yields of dry mycelium after 10 days are given in Table III. Special cultural and other characters are also recorded.

NOTES ON CULTURES OF P. SORGHINA

Marked differences were observed on different media in the case of *P. sorghina.* In the majority of cultures growth was mostly superficial, but in the cultures of cellulose, adonite, mannite, dulcite, sorbite and pectin it was both superficial and subterranean. Chromogenesis was evident in the case of the liquid in many cultures, varying from pale yellow (xylose and lactose) and flesh (glucose, maltose, sucrose, starch and inulin) to rattan (ethyl alcohol) and pink 1T (glycerine). The peptone liquid was dark brown and both the gelatin and casein cultures were nugget bronze. In the cultures of rhamnose, dextrine (white), gum arabic, cellulose, adonite, mannite, dulcite, sorbite, citric acid, sodium asparaginate, olive oil and blood fibrin, after 10 days the liquid had not altered in color.

On the whole, pycnidia were formed abundantly in all cultures with the exception of rhamnose, mannite and dulcite which had only a fair number, glycerine and sorbite only a few and adonite and citric acid none at all.

The cellulose cultures formed pycnidia at first only where the solid material protruded to the surface. After 50 days, the surface also appeared somewhat translucent and gelatinous. The glycerine cultures were also noted to form gelatinous masses in the bottom of the flasks.

Large crystals containing magnesium ammonium phosphate were suspended from underneath the fungus mats in the cultures of peptone, gelatin and blood fibrin after about 12 days. Odor of ammonia was also distinct and the solution strongly alkaline to litmus in the gelatin cultures.

The growth in the casein cultures was characteristically mallow color, later a Java brown. They were also very malodorous, but no H_2S could be detected.

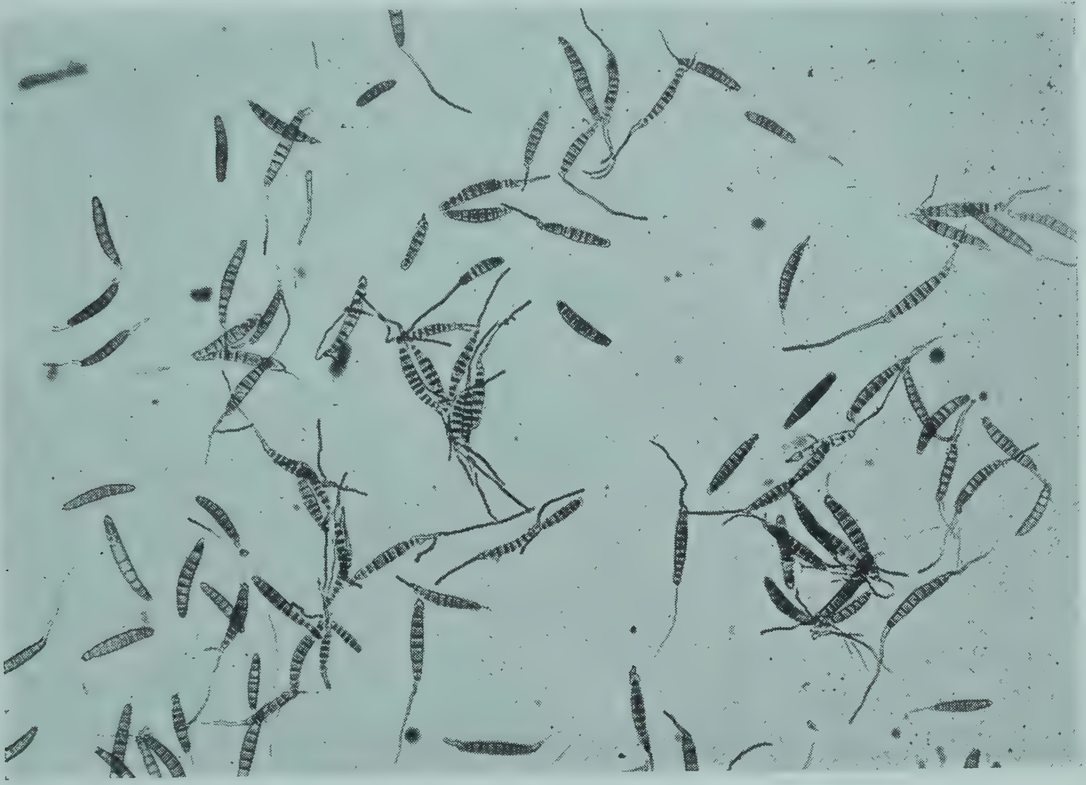

Fig. 7.—Germination of spores of *Helminthosporium ocellum* in 1% sucrose solution after two hours at 30°C. (X 87.)

NOTES ON CULTURES OF H. OCELLUM

In the case of *H. ocellum,* none of the cultures developed any chromogenesis as found in the case of *P. sorghina,* except in the case of casein cultures, which, after about two months, assumed the color of Arab rugby tan. The subterranean portion of the growth at first was practically colorless, while the superficial growth was ivy green in color. Spore formation was abundant in all cultures which made growth.

The peptone cultures of *H. ocellum* showed large crystals containing magnesium ammonium phosphate hanging from the surface after only 10 days and the cultures were malodorous. No crystals of this compound were noted in the cultures containing either gelatin or casein, even after two months, but in the case of blood fibrin they were very abundant after this extended period. The gelatin cultures showed no odor of ammonia as did those of *P. sorghina,* but the casein cultures were very malodorous.

DISCUSSION OF RESULTS

Striking differences are seen to occur as regards the utilization of various sources of carbon by the two organisms. For example, among the monosaccharoses, fructose is preferred by *H. ocellum,* while d-galactose is preferred by *P. sorghina.* Among the disaccharoses, sucrose is preferred by *H. ocellum,* while maltose gave the greatest growth for *P. sorghina.* Among polysaccharoses, white dextrine is preferred by *H. ocellum,* while starch is preferred by *P. sorghina.*

Over a 10-day period, the order of utilization as measured by dry weights of mats was as follows: *H. ocellum*—pectin, dextrine (white), peptone, fructose, xylose, sucrose, starch, d-galactose, glucose, gelatin, d-mannose, maltose, dextrine (yellow), inulin, lactose, olive oil, raffinose, gum arabic, arabinose, ethyl alcohol, rhamnose and mannite (equal), inosite, sodium lactate, sodium asparaginate, glycerine and dulcite. For *P. sorghina*—raffinose, d-galactose, starch, pectin, olive oil and maltose (equal), dextrine (white), glucose, peptone, glycerine, sucrose, xylose, lactose, gelatin, inulin, mannite, inosite, d-mannose, fructose, dextrine (yellow), ethyl alcohol, arabinose, gum arabic, rhamnose, sodium asparaginate, dulcite, amyl acetate, sorbite, adonite and citric acid. Good growth was secured by both fungi on cellulose, casein and blood fibrin, but on account of the nature of these substances dry weight of the mycelium could not be secured.

The marked utilization of pectin, especially by *H. ocellum,* is in keeping with pronounced intercellular growth by both the parasite and saprophyte in the host as shown by histological studies.

It is significant that while the proteins and their higher derivatives can be utilized readily as sources of carbon by both the parasite and saprophyte as shown by good growth on gelatin, blood fibrin, casein and peptone, certain organic acids and salts of organic acids, e.g. sodium asparaginate, proved to be poor sources of this element, especially in the case of *H. ocellum,* possibly due in part to unfavorable pH of the medium. In fact, of all the latter substances investigated, citric acid and amyl acetate were utilized only by *P. sorghina* and the growth of this fungus on sodium asparaginate was 14 times better than in the case of *H. ocellum.*

The marked utilization of olive oil and glycerine by *P. sorghina* as compared with *H. ocellum* indicates that certain fat compounds and acid-alcohol derivatives in the host tissues are largely destroyed by the saprophyte.

That ethyl alcohol, a product of the decomposition of glucose, is utilized by both organisms, is of special interest. White *(60)* also found that *Fusarium lycopersici* could make use of this primary alcohol in its metabolism and used this fact to explain the continued increase in dry weight of the fungus, even after glucose had disappeared from nutrient cultures containing no other source of carbon.

The formation of ammonia gas by *P. sorghina* when gelatin was used as a source of carbon, and magnesium ammonium phosphate in considerable quantities by *H. ocellum* and *P. sorghina* when certain protein compounds and their higher derivatives are decomposed in the presence of the mineral medium employed, is worthy of emphasis and will be discussed in connection with the work on toxic substances produced.

A comparative examination of the physiological activity of *H. ocellum* and *P. sorghina* (see Table III) at room temperatures (28-30°C.) based on the average dry weight of fungus after growth on identical media for the same length of time and under similar environmental conditions, employing 25 different sources of carbon, reveals the fact that in only one instance did *H. ocellum* show superiority over *P. sorghina* and that is in the case of fructose. The total yield of dry mycelium on 25 media shows *H. ocellum* 1,963.0 grams and *P. sorghina* 3,895.0 grams. Thus it would appear that under the conditions of the above experiments, the saprophyte is on the average twice as active physiologically as the parasite in breaking down and utilizing organic carbon compounds suitable for their life processes. Since the temperature factor was in favor of *P. sorghina*, however, it should be borne in mind that the result would undoubtedly be very different if the experiment was conducted at the optimum temperature for the growth of the pathogene.

THE ENZYMES PRODUCED BY H. OCELLUM FARIS AND P. SORGHINA SACC.

Since both the parasite and saprophyte were found to be able to utilize effectively so many sources of carbon in their metabolism, it was therefore considered desirable to study certain of the enzymes produced by them, not only as a confirmative measure, but also to gain some relative conception as to the activity of the enzymes produced by the two fungi.

From the results already reported, indications exist that the following important enzymes are produced, among others, by both fungi: invertase, lactase, amylase, maltase, inulase, pectinase, cellulase, lipase, erepsin, trypsin and pepsin. It was therefore decided to make confirmative tests for the majority of these and study their activity.

EXPERIMENTAL METHODS

The fungi were grown on White's *(60)* modified Richard's solution, but containing 1% glucose instead of 5%. In place of using plain distilled water, however, a sugarcane leaf decoction was employed. (Twenty-five grams of fresh cane leaves cut into small portions, boiled for 30 minutes in 6,500 cc. of distilled water and then filtered.)

Pyrex Erlenmeyer flasks, each containing 200 cc. of the above medium, were autoclaved for 20 minutes at 20 pounds pressure. After incubation for three days, they were inoculated with a loopful of spores from a single-spore culture of either *H. ocellum* or *P. sorghina*, obtained from cane leaves.

The growth of both fungi was allowed to take place at room temperature (approximately 28°C.). Under these conditions which greatly favored the rapid growth of *P. sorghina* as shown later, in order to secure approximately the same amount of mycelium from each fungus, *H. ocellum* was allowed to grow for 14 days and *P. sorghina* only 6 days. The mycelial mats were then removed (each fungus being kept separate), washed in running water for 15 minutes, squeezed out by hand and treated with acetone and ether according to the method used

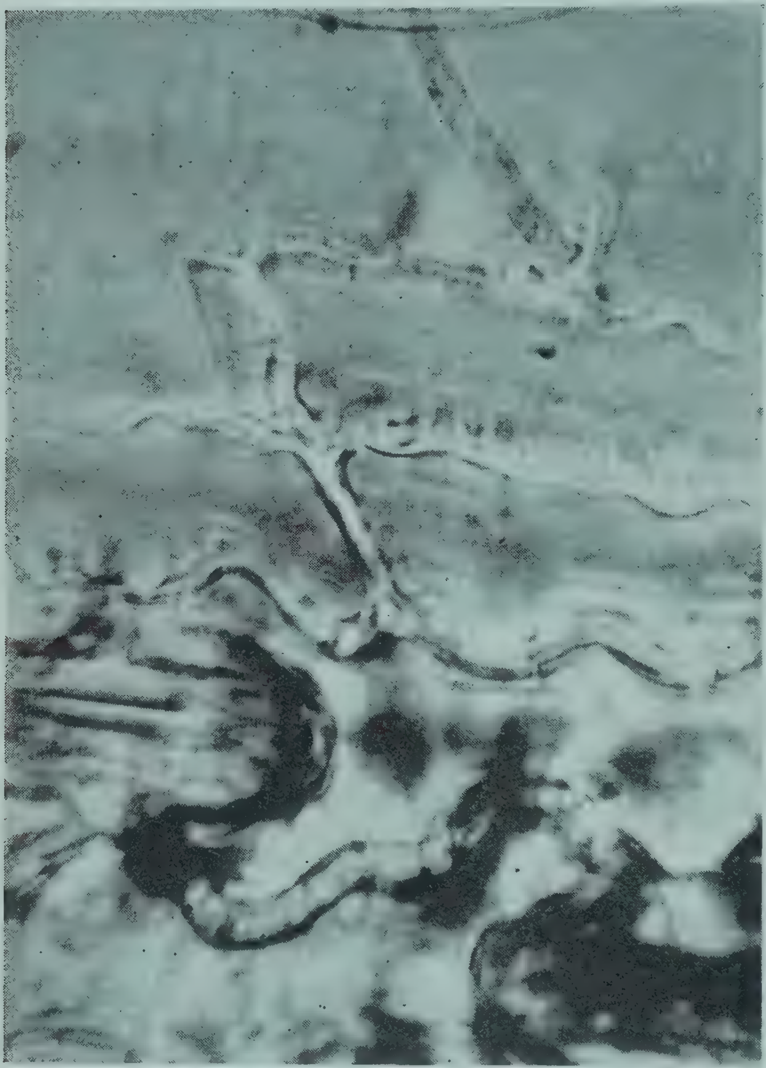

Fig. 8.—Surface view of D. 74 leaf section made parallel to the surface, showing penetration of *H. ocellum* into short epidermal cell and also into a stoma. (X 1108.)

by Harter and Weimer *(29)* in their studies with *Rhizopus tritici.* The dried mycelium was not stored, but was immediately powdered in a clean mortar without the use of sand and a weighed quantity used for the following experiments.

Experiment Series 1:—The experiments with the two fungi—*H. ocellum* and *P. sorghina*—were conducted in the same manner. Samples of powdered mycelium consisting of 0.25 gram were placed in 125 cc. pyrex Erlenmeyer flasks which had previously been carefully cleaned and dried. Twenty-five cc. of 1% solution of sucrose, starch and maltose and of a 1% cellulose* suspension as well as 25 cc. of 0.5% pectin, were placed in each of two flasks. Likewise, 25 cc. of distilled water were added to the same amount of mycelium in each of four flasks for the determination of the amount of autolysis. Two control flasks containing in each case 25 cc. of each of the above sucrose, starch, maltose and pectin solutions and cellulose suspension were held as controls. Five cc. of toluol were added to all the flasks as an antiseptic and they were held in a constant temperature incubator at 40°C. for 24 hours. At the end of this period, the whole series of flasks were steamed for 15 minutes and their

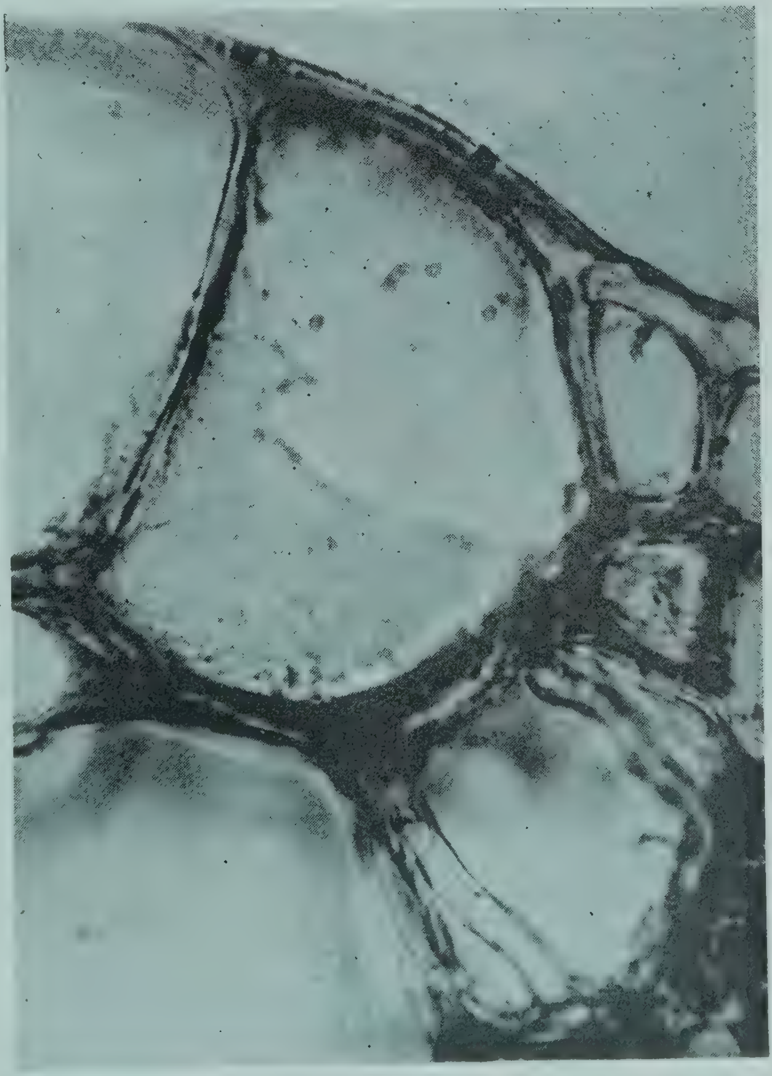

Fig. 9.—Cross-section of D. 74 leaf showing penetration of *H. ocellum* directly through wall of epidermis of motor cell. Also shows large mycelium of the pathogene within cell adjoining the chlorophyll-bearing parenchyma. (X 1108.)

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*The weighed portion of genuine ashless "Whatman" filter paper No. 42 was thoroughly ground in a clean mortar with a small quantity of distilled water before transferring to the flask.

contents tested for reducing sugars by the general gravimetric method employing Fehling's solution as recommended by the Association of Official Agricultural Chemists*(5)*.

For each fungus, the average amounts of reducing sugars present in the two flasks minus that formed on the average by autolysis and that in the original solutions are presented in Table IV.

TABLE IV.—THE AVERAGE QUANTITY OF REDUCING SUGARS IN MGS. PER 10 CC. AFTER 24 HOURS AT 40°C. RESULTING FROM THE HYDROLYSIS OF CANE SUGAR, STARCH, MALTOSE, INULIN, PECTIN AND CELLULOSE BY 0.25 GRAMS OF POWDERED HYPHAE OF H. OCELLUM AND P. SORGHINA (SEPARATELY) IN 25 CC. OF SOLUTION.

Chemical Substrate	Percent Concentration	Milligrams of reducing sugar per 10 cc.	
		H. ocellum	*P. sorghina*
Sucrose	1.0	46.0	83.4
Starch	1.0	18.7	23.7
Maltose	1.0	7.6	16.5
Inulin	1.0	00.0	6.3
Pectin	0.5	00.0	6.3
Cellulose	1.0	00.0	00.0

Experiment Series 2:—The two fungi were grown on the same medium and at the same temperature as employed for Series 1. *H. ocellum* was grown for 27 days, while *P. sorghina* was grown for only 14 days. In making the tests, the same amount of dry mycelium of each fungus was employed as well as quantity of substrate, preservative, etc., so that the results are comparable, with the exception of any differences which might arise as a result of the varying ages of the mycelial mats and the fact that *P. sorghina* was grown nearer its optimum temperature than was *H. ocellum.*

Erepsin:—Powdered mycelium—0.109 gms. + 25 cc. of 0.1% peptone + 0.2 gm. thymol in each of two 125 cc. Erlenmeyer flasks. Two controls were run, using autoclaved mycelium. All were incubated at 40°C. for 24 hours and the solutions tested for the Biuret reaction.

Results showed in the case of both fungi only a very faint bluish color in the case of the cultures with normal mycelium, while the autoclaved mycelium gave typical reddish-violet coloration.

Trypsin: — Powdered mycelium—0.109 gm. + blood fibrin (stained with 1% congo red and autoclaved for 15 minutes at 15 pounds pressure) + 2 cc. of N/10 Na_2CO_3 + 1 mg. thymol in each of two test tubes. Two controls were run, using autoclaved mycelium. All were incubated at 40°C. for 24 hours.

In the case of both fungi, results showed that the normal mycelium cultures had a distinct objectionable odor, the fibrin had lost color and swelled somewhat and the liquid was thick, opaque and slightly pink. The control cultures had no odor and showed no visible changes.

Pepsin:—Powdered mycelium —0.109 gm.+ blood fibrin (prepared as above) + 2 cc. of 0.2% HCl + 1 mg. thymol in each of two test tubes. Two duplicate control tubes prepared using autoclaved mycelium. All cultures incubated at 40°C. for 24 hours.

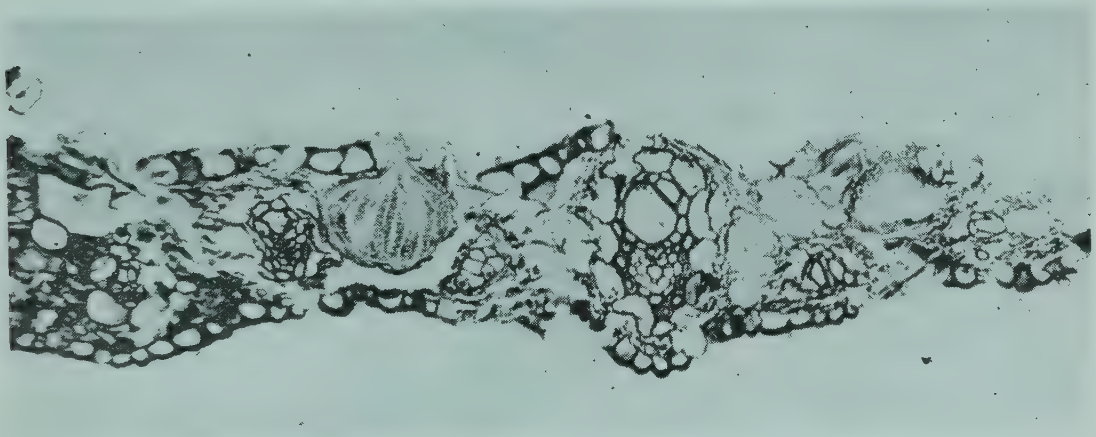

Fig. 10.—Cross-section of leaf of CP. 27-139, showing fruit bodies of both *Leptosphaeria sacchari* (left) and *Phyllosticta sorghina* (right) in the same section. (X 136.)

The *H. ocellum* cultures of normal mycelium became very malodorous, with slight swelling and loss of color. The color of the liquid was very slightly pink and it was thick and opaque.

No differences could be noted in the cultures of normal mycelium of *P. sorghina* and the four control tubes also remained unchanged. The *P. sorghina* cultures were incubated for 72 hours without any significant changes being observed.

Lipase:—Trials were conducted both with methyl acetate and olive oil as substrates. In both cases, care was taken to mix the powdered mycelium with the subtrate properly before adding the acid as an activator, since the possibility existed that the acid might destroy the enzyme as was found in the case of castor bean lipase by Haley and Lyman*(30)*.

A. Powdered mycelium –0.3 gm. + 10 cc. distilled water + 2 cc. methyl acetate + 1 cc. of N/30 oxalic acid as an activator + 5 cc. toluol placed in each of two 125 cc. Erlenmeyer flasks. Two duplicate cultures prepared with mycelium which had been boiled for 15 minutes. All incubated at 40°C. for 24 hours. After the addition of 50 cc. of neutral 95% alcohol and 1 cc. of neutral 1% phenolphthalein solution, each was titrated with N/10 KOH in 95% alcohol.

B. Powdered mycelium –0.3 gm. + olive oil –1.0 gm., these thoroughly mixed and then 0.6 cc. of 1% acetic acid added. Toluol 1 cc. used as a preservative. Two test tube cultures prepared as above and two control tubes prepared similarly, but mycelium which had been boiled for 15 minutes was used instead. All were incubated for 24 hours at 40°C. After the incubation period, the contents of each tube were carefully transferred to a 125 cc. titration flask, using 50 cc. of neutral 95% alcohol, 1 cc. of neutral 1% phenolphthalein solution added and the mixture titrated with N/10 KOH in 95% alcohol.

C. Four tubes prepared exactly as in B (two with normal unheated mycelium and two controls with boiled mycelium) but these incubated at 40°C. for 43 hours instead.

The results of the trials under A, B and C for each fungus separately are given in Table V.

TABLE V.—Extent of Hydrolysis Produced by 0.3 gm. of Powdered Mycelium of H. ocellum and P. sorghina (separately) on 2 cc. of Methyl Acetate and 1.0 gm. of Olive Oil.

Exp.	Substrate	Normal or heated mycelium	Incubation hours at 40°C.	Average cc. of N/10 KOH used in titration	
				H. ocellum	*P. sorghina*
A.	Methyl acetate	Normal	24	3.8	9.8
	Methyl acetate	Heated	24	2.0	2.9
B.	Olive oil	Normal	24	6.9	4.5
	Olive oil	Heated	24	3.1	3.4
C.	Olive oil	Normal	43	8.0	6.0
	Olive oil	Heated	43	3.0	4.0

DISCUSSION OF RESULTS

Definite confirmative evidence of the presence of the enzymes invertase, amylase, maltase, lipase, erepsin and trypsin has been obtained for both *H. ocellum* and *P. sorghina.* Pepsin was also definitely confirmed for *H. ocellum,* but could not be detected in the case of *P. sorghina.* Inulase and pectinase were confirmed for the latter fungus, but not for *H. ocellum.* Conclusive evidence of the presence of cellulase has not been obtained by the methods used, although both fungi grew well on media with cellulose as the sole source of carbon.

The activity of invertase and amylase is very pronounced for both fungi, especially the former enzyme, and serves to emphasize the part evidently played by it in causing inversion of sucrose in various parts of the host.

The enzymes pepsin, trypsin and erepsin no doubt play a significant role in the attack on cellular proteins and their derivatives by the parasite. The saprophyte, by secreting the latter two enzymes, is also able to aid effectively in the destruction and removal of complex organic substances, thus hastening the rapid shrinkage and collapse of tissue in the holonecrotic zone of the original eye spot lesions. The formation of ammonia and its accumulation in the surrounding medium in the form of magnesium ammonium phosphate is undoubtedly brought about by the action of the above proteolytic enzymes.

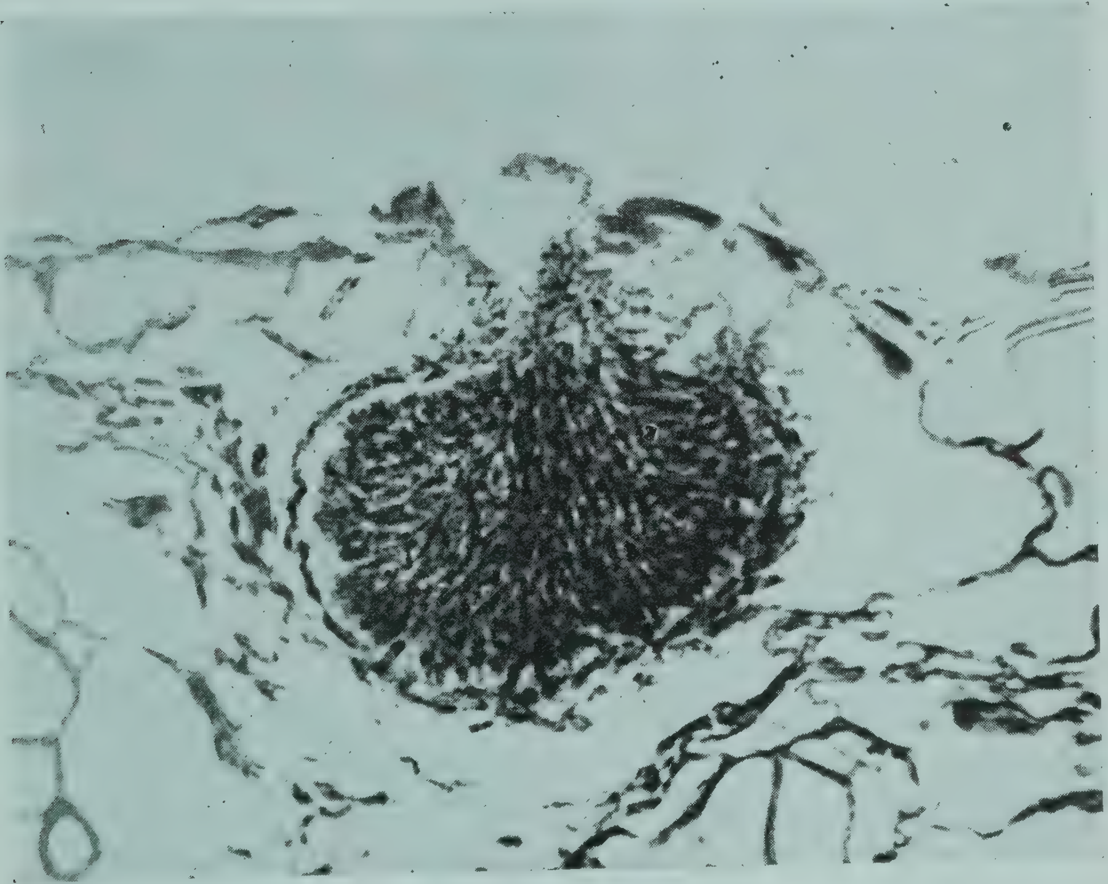

Fig. 11.—Cross-section of leaf of CP. 27-139, showing pycnidium of *P. sorghina* opening to the upper surface. (X 590.)

Although *P. sorghina* made much greater growth on olive oil than *H. ocellum* under similar environmental conditions, the lipase secreted by the latter is apparently more active on this substrate than that of the former, although the reverse is seen to hold true with the substrate methyl acetate. This latter behavior was rather to be expected, however, since *H. ocellum* failed to grow at all on amyl acetate as a source of carbon, while *P. sorghina* made some growth on this substrate.

THE RELATION OF ASSOCIATED ORGANISMS TO H. OCELLUM AND TO ONE ANOTHER

During the isolation studies of ring spots on cane leaves, sheaths and stems, a number of fungi other than *H. ocellum* were very frequently found associated with such spots and later work showed that these were nonpathogenic forms. Among these were *Phyllosticta sorghina, Leptosphaeria sacchari, Nigrospora* sp., *Spondylocladium* (*Acrothecium*) sp. and *Alternaria* sp. The latter fungus was encountered so seldom that it was omitted from the association experiments performed.

The importance of studying the effects of associated organisms to the growth and development of parasitic microörganisms has recently been extensively reviewed by Fawcett*(27)*. This author cites several examples from his own work and from the literature to show that when certain parasites are inoculated with their associated saprophytes, definite and marked effects are produced. In some combinations, lesions are formed more readily and develop more rapidly, while in others, the parasite appears to be inhibited in its action so that it accomplishes no appreciable harm. The object of the following experiments was to determine if possible whether any antagonistic or mutual relationships existed between the above mentioned fungi. It was also hoped that the information obtained would prove valuable in suggesting combinations of fungi in known mixtures for pathogenic studies and also help to explain the frequent occurrence of certain fungi together in the same lesions.

EXPERIMENTAL METHODS

It was decided to study the effects at room temperature (28-30°C.) of association of pairs of fungi on potato glucose agar in petri dishes. After pouring the plates inoculations were made separately in each hemisphere of the dish with pure cultures of the two fungi to be studied. Trials were made in triplicate and the contour of each colony traced in ink as it developed. All possible combinations of the above fungi were tried in pairs. The growth of *L. sacchari* proved to be so slow that this fungus was started about a week in advance of inoculating the other fungus opposite it. The results are given in Table VI.

TABLE VI.—RESULTS OF GROWING DIFFERENT PAIRS OF FUNGI IN POTATO GLUCOSE AGAR AT 28-30°C., WITH SPECIAL REFERENCE TO H. OCELLUM AND ITS ASSOCIATED SAPROPHYTES.

Exp. No.	Associated Fungi	Results
A–1	*H. ocellum* + *L. sacchari*	*L. sacchari* apparently not influenced by presence of *H. ocellum*, but the latter definitely grew away from the former, indicating that *L. sacchari* is antagonistic to *H. ocellum*
A–2	*P. sorghina* + *L. sacchari*	Both fungi mutually agreeable
A–3	*Spondylocladium* + *L. sacchari*	Both fungi mutually agreeable
A–4	*Nigrospora* + *L. sacchari*	*Nigrospora* not toxic to *L. sacchari*, but the latter inhibited growth of former and in most instances prevented close contact of the two. *L. sacchari* is therefore definitely toxic to *Nigrospora*
B–1	*P. sorghina* + *Nigrospora*	Both fungi mutually agreeable
B–2	*P. sorghina* + *Spondylocladium*	Both fungi mutually agreeable
B–3	*P. sorghina* + *H. ocellum*	Mutually agreeable. Both colonies finally grew in contact with each other
B–4	*P. sorghina* + *P. sorghina*	Mutually agreeable colonies
C–1	*H. ocellum* + *Spondylocladium*	Mutually agreeable
C–2	*H. ocellum* + *Nigrospora*	Both fungi definitely toxic to each other
C–3	*Spondylocladium* + *Nigrospora*	Mutually agreeable

DISCUSSION OF RESULTS

The results indicate that *P. sorghina, L. sacchari* and *Spondylocladium* sp. may be mutually associated with *H. ocellum* in eye spot or ring spot lesions. Because of the very rapid growth of *P. sorghina* as compared with *Spondylocladium* and especially *L. sacchari*, it is evident that the former is usually the first organism to follow the parasite, provided equal conditions for inoculation are provided.

The experimental data clearly indicate also that under the conditions investigated, *Leptosphaeria sacchari* is not hindered in its growth either by the pathogene *H. ocellum* or any of its frequently associated saprophytic fungi. In spite of its very slow growth, if it becomes inoculated into the eye spot lesions, it is to be expected that it will eventually occupy a conspicuous place in the dead tissue. This is in agreement with field observations in the case of infected leaves, for under conditions favoring the dissemination of this saprophyte it may be almost constantly associated with the lesions on old dead material, even though the other saprophytes might have occupied a significant role in the destruction of the diseased tissues before it.

The interesting mutual toxic effect existing between *H. ocellum* and *Nigrospora* sp. and the inhibitory effect of *L. sacchari* when associated either with *H. ocellum* or *Nigrospora* sp. in artificial culture, might not be so pronounced or might be absent entirely in actual living tissues. Further, the results secured might be due to changes in pH of the substrate rather than the production of an actual toxin.

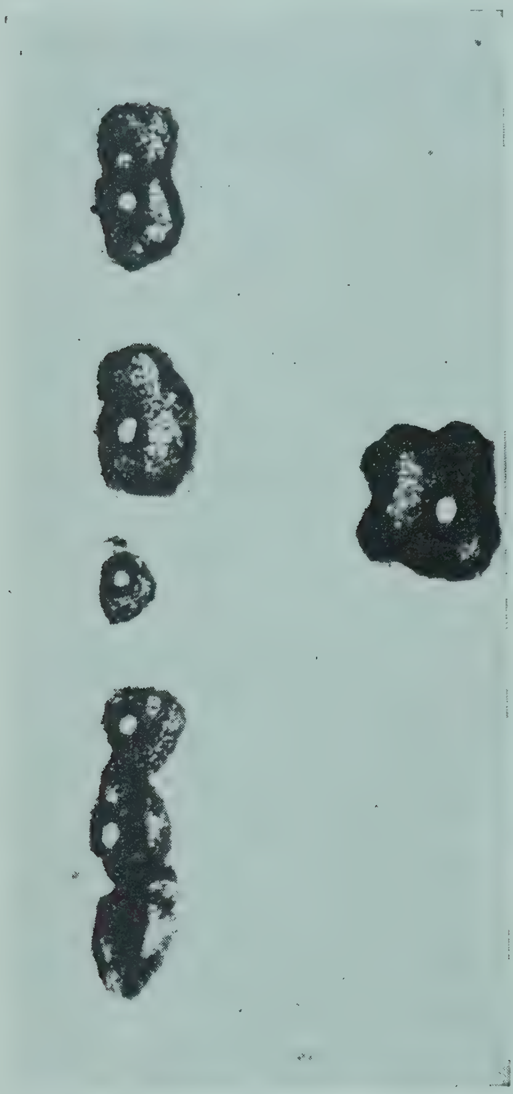

Fig. 12.—Linear arrangement of pycnidia of *P. sorghina* between veins of leaf of B 417. (X 136.)

RELATION OF TEMPERATURE TO GROWTH

Halma and Fawcett*(28)* report experiments on the relation of growth of *H. sacchari* to maintained temperatures. Lee*(40)* in reviewing the above authors' work, refers to the fungus as the one causing the eye spot in Hawaii, so that the possibility exists that the fungus studied was identical with *H. ocellum* Faris, although no spore or conidiophore measurements of the cultures employed are available for comparison. Further, no statement is made that the culture used was derived from a single spore, therefore the results reported could possibly be based on a culture secured by the ordinary tissue-planting method without any subsequent purification.

As a result of their studies, Halma and Fawcett do not commit themselves with regard to the optimum temperature any more than to state that it was between 20°C. and 29°C. On the other hand, Lee*(40)* in reviewing the above authors' work, states that the fungus grows most rapidly at about 84°F. (29°C.). Cook*(19)*, however, states that field records in Porto Rico indicate that the eye spot organism makes its best growth with an average outdoor temperature ranging from 73°F. to 77°F. (22.8°C. to 25°C.).

With regard to *P. sorghina* and *Leptosphaeria sacchari,* no reference could be found giving studies on the temperature relations of these two fungi. It was therefore decided to study this factor for both of these organisms also, since these data would allow of a better conception of environmental conditions affecting the growth of these saprophytes in the tissues of the host already damaged by *H. ocellum* and the transformation of eye spot lesions into typical ring spots.

EXPERIMENTAL METHODS

Single-spore strains of all three organisms were used in the studies here reported. The medium consisted of hard potato-glucose agar.* The temperatures desired were maintained in special constant temperature chambers† which did not show a fluctuation of more than 0.5°C. at any time during the work. Enough agar medium was made up in one batch to run the complete series in sextuplicate for each temperature. After preliminary trials, the duration interval for the experiment was chosen to be six days. With the lower temperatures, no difficulty was experienced in keeping the humidity of the chambers such that the medium did not dry out. In the case of temperatures above 29°C., however, battery jars with wet absorbent cotton in the bottom and a cover over the top were found to be very satisfactory in preventing the drying out of the medium.

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*Two hundred gms. cubed potatoes boiled in 1000 cc. tap water. To the strained potato broth was added 1% glucose and 2% shredded agar.

†This work conducted with the aid of the facilities provided by the Departments of Plant Pathology and Entomology, Cornell University.

Spore suspensions were made from young vigorous cultures one week old growing on the same kind of medium used for the experiments. One small loop of the suspensions was used to inoculate the center of each previously poured agar plate. The poured plates were immediately placed in their respective temperature chambers in the dark. After six days, the average diameter of each colony was measured and the average from the six cultures of each fungus in each chamber computed. The agar medium as made up was found to have a pH of 6.47, this figure being determined electrometrically.

EXPERIMENTAL RESULTS

A summary of the results of the average diameters of the colonies of the three fungi in the various temperature chambers appears in Table VII. The results are also represented graphically in Fig. 21 and photographically in Figs. 18, 19 and 20.

DISCUSSION OF RESULTS

The optimum temperature for growth of the three organisms is seen to be as follows: *H. ocellum* 23.5°C., *P. sorghina* 27.0°C. and *L. sacchari* 21.0°C. It is significant that at the optimum temperature, *H. ocellum* makes a greater growth than *P. sorghina* at its optimum. Further, the maximum temperature for *H. ocellum* lies at some point above 38°C., while that for *P. sor-*

TABLE VII.—AVERAGE DIAMETER OF COLONIES OF H. OCELLUM, P. SORGHINA AND LEPTOSPHAERIA SACCHARI AFTER SIX DAYS AT DIFFERENT TEMPERATURES ON POTATO-GLUCOSE AGAR HAVING AN ACIDITY OF pH 6.47.

Temperature °C.	Average diameter of colony in cms.		
	H. ocellum	*P. sorghina*	*L. sacchari*
3.0	0.0	0.6	0.0
6.0	0.3	0.7	0.2
8.5	1.1	. . .	. . .
10.6	1.6	. . .	. . .
11.0	. . .	2.6	0.6
14.5	2.1	4.1	0.7
17.7	4.2	. . .	. . .
18.0	. . .	5.5	0.9
21.0	6.9	6.7	1.1
23.5	9.0	. . .	. . .
24.0	. . .	7.0	1.0
27.0	. . .	7.8	0.9
28.0	6.1	. . .	. . .
29.0	. . .	6.9	0.5
31.0	4.5	. . .	. . .
33.0	4.3	. . .	. . .
34.0	. . .	0.6	0.0
35.0	1.2	. . .	. . .
38.0	0.8	0.0	. . .

ghina lies between 34 and 38°C. and for *L. sacchari* between 29 and 34°C. The optimum temperature for growth of *H. ocellum* in culture agrees well with observations in Florida and elsewhere that eye spots and ring spots are especially abundant during the cooler periods of the winter months when the average temperatures range between 22°C. and 25°C. Higher temperatures between 30°C. and 35°C. are seen to be very unfavorable to the growth of the pathogene and practically inhibitory to *L. sacchari*, an organism of very slow growth even under optimum conditions.

Photographs of *H. ocellum* in this series also bring out most interestingly the characteristic appearance of the colonies at the different temperatures. The typical sectorial type of colony figured at 28°C. (see Fig. 18) and mentioned by Faris *(26)* as simulating dichotomous branching and as being characteristic of the eye spot fungus, especially on 1% sucrose agar, is here shown to be greatly influenced by temperature relations and is absent at the optimum and toward both extremes of minimum and maximum temperatures. Further, the characteristic smoky-colored mycelium is absent at the extreme temperatures of 6.0, 8.5, 10.6 and 38.0°C. after six days.

Notes on spore formation after six days by the three organisms at the various temperatures show that *H. ocellum* failed to form conidia at the lower temperatures up to and including 10.6°C. and at the higher temperatures of 35 and 38°C. At all intervening temperatures spore production was abundant, especially at the optimum for growth.

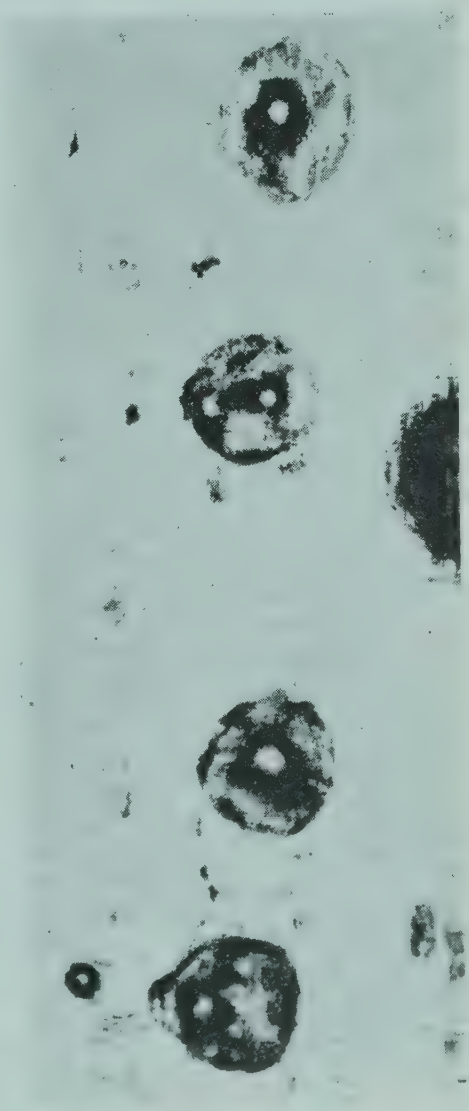

Fig. 13.—Linear arrangement of perithecia of *Leptosphaeria sacchari* between veins of leaf of CP. 27-139 in the holonecrotic zone of a ring spot. (X 136.)

In the case of *P. sorghina*, pycnidia and spore formation occurred only between 14.5°C. and 29.0°C., while for *L. sacchari,* pycnidia and spores of the imperfect stage occurred between 14.5°C. and 27°C.

RELATION OF HYDROGEN-ION CONCENTRATION TO GROWTH

Although the relation of acidity and alkalinity to growth has been studied in detail for a large number of fungi, this information is lacking in the case of *H. ocellum* and *P. sorghina,* the two fungi of special importance in the case of ring spot.

EXPERIMENTAL METHODS

Standard "Difco" potato-glucose agar was employed, using 40 grams per liter as per directions. Enough medium was made up at once to take care of four plate cultures for each hydrogen-ion concentration in the case of each fungus. After sterilization, the hydrogen-ion concentration of the normal medium was determined and the remainder adjusted with normal HCl and NaOH under aseptic conditions. The pH was determined electrometrically after dilution with neutral distilled water as mentioned by Lisse et al.*(42)*, using the quinhydrone electrode. For the determination of alkalinities above pH 7.5, the "Hellige" colorimetric outfit was employed.

TABLE VIII.—Average Diameter of Colonies of H. ocellum and P. sorghina After 10 and Six Days Respectively, Grown at Different Hydrogen-ion Concentrations on Potato Glucose Agar at 28°C.

pH of Medium	Average diameter of four plate colonies, cms.	
	H. ocellum	*P. sorghina*
3.1	1.7	1.7
3.2	...	2.5
3.4	2.5	...
3.7	2.6	3.9
4.1	3.0	4.8
4.5	3.2	...
4.7	...	6.0
5.6*	3.3	7.3
5.8	3.4	...
6.0	...	7.6
6.5	...	6.9
6.7	3.8	...
7.2	...	3.7
7.4	1.5	3.4
8.0	1.3	...
8.2	0.7	...
8.4	...	1.4
8.6	0.0	...
8.7	0.0	0.8

*Normal medium before the addition of either acid or alkali.

After pouring the plates, they were incubated for 24 hours before being inoculated with a loop of spores from an aqueous suspension of spores of the particular organism in the center of the plate. Plates were incubated at approximately 28°C. for six days in the case of *P. sorghina* and 10 days in the case of *H. ocel-*

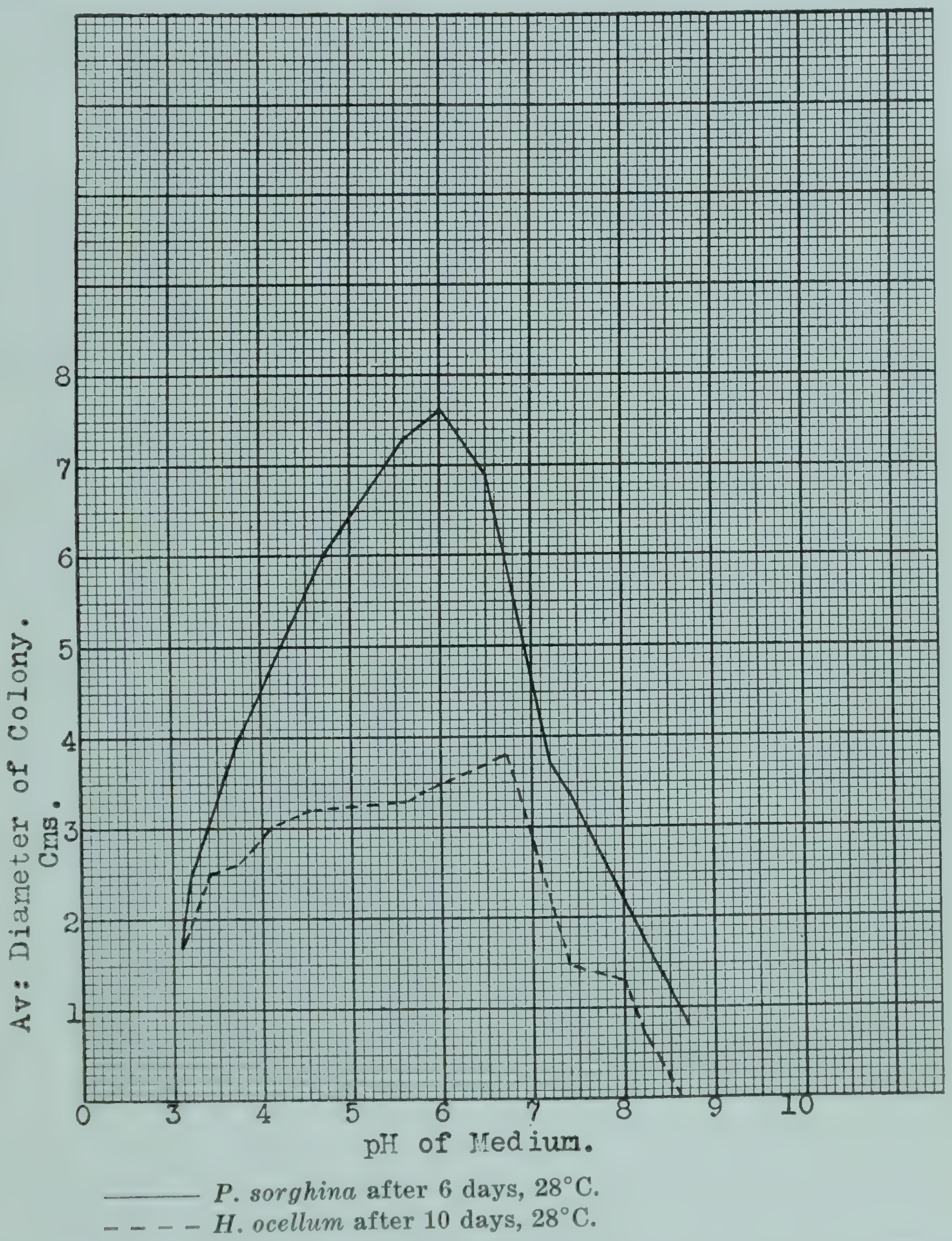

Fig. 14.—Graphical representation of the relation of pH of medium to growth of *H. ocellum* and *P. sorghina* after 10 and 6 days, respectively, at approximately 28°C.

lum. At the end of this period, the average diameter of the colony in each plate was determined and the average for each pH computed.

EXPERIMENTAL RESULTS

The experimental results are given in Table VIII and shown graphically and photographically in Figs. 14, 22 and 23.

DISCUSSION OF RESULTS

The optimum growth for *H. ocellum* is seen to be at pH. 6.7, while for *P. sorghina* it is at pH 6.0. It is significant that the range for growth of the latter fungus extended further on the alkaline side of the scale than in the case of *H. ocellum*, which made no growth beyond pH 8.2 for the period investigated. Both fungi, however, are seen to be able to tolerate rather acid media, even as great as pH 3.1.

While no significant difference in color of colonies could be observed in the case of *H. ocellum*, there was a definite correlation between pH of medium and pigmentation (production of pink, salmon and other shades) by *P. sorghina*. Orange peel colors seemed to predominate between the range pH 3.1-4.1 and salmon, cherry blossom and copper leaf between pH 4.7 and 7.4, while no pigmentation occurred on the alkaline side at pH 8.4 and 8.7.

Since *H. ocellum* fails to produce in artificial media the pigments necessary for inducing the characteristic Burgundy or Spanish raisin shades frequently encountered in eye spot and ring spot lesions, especially in the plesionecrotic zone, support is given to the theory that these distinct colors are largely due to the chemical reactions produced by the accompanying saprophytic organism *P. sorghina*. It has already been noted that certain cultures of *H. ocellum* gave rise to colored by-products having the appearance of Arab rugby tan and it is indeed possible that certain leaf proteins might react in a manner with this fungus to give similar pigments.

RELATION OF LIGHT TO GROWTH

Since light has been noted to have a marked effect on the growth and reproduction of a number of fungi and because ring spots on the lower leaves develop well in the shade, information on this factor seemed to be desirable. Priode*(47)* working with *Hel-*

minthosporium sp., the cause of the target blotch disease of sugarcane leaves, claims that the exclusion of light greatly retards mycelium development, but the production of conidia by the fungus is greatly stimulated.

EXPERIMENTAL METHODS

Twenty-four petri dishes were poured from a uniform lot of fresh potato glucose agar having a pH of 5.6. After the dishes cooled, the center in each case was inoculated with a loopful of an aqueous suspension of spores, 12 dishes being inoculated with *H. ocellum* and 12 with *P. sorghina.* Immediately after inoculation, six plates of each fungus were placed in a large light-tight metal can on a table in the laboratory and the other 12 plates spread out singly on the same table which received at no time anything but reflected sunlight from the sky after passage through ordinary window glass. Direct rays from the sun were not allowed to shine on the plates or the box with the plates in the dark because of the temperature factor which would be introduced.

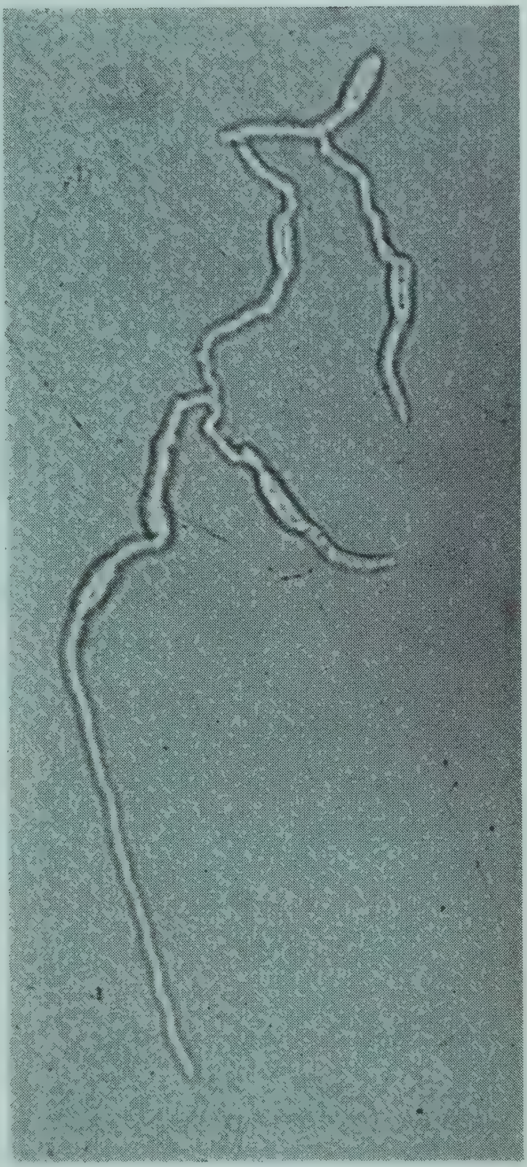

Fig. 15.—Germination of spores of pycnidial stage (*Phyllosticta saccharicola* Henn.) of *Leptosphaeria sacchari* in distilled water after 23 hours at 28°C. Note anastomosing of germ tubes. (X 590.)

RESULTS

After nine days, the *H. ocellum* cultures in the dark showed a mean average diameter of 2.8 cms., while those in the light showed a mean average of 2.3 cms. Since variations in diameters in each group occurred from 1.9 to 3.2 cms., it is evident that light exerted no significant difference in vegetative growth. Further, no difference could be observed in the production of conidia by the two groups.

After five days, the *P. sorghina* cultures showed a difference in mean average diameter of colonies from the two series amounting to only 0.1 cm., which was more than the variation occurring in colonies in each group. However, the cultures in the dark showed no zonated rings of pigmented mycelium, the colonies being a uniform copper-leaf color. Colonies in the light, on the other hand, were all bright salmon colored in the center and possessed two zonate rings of pinkish brown outside of the center. Between the rings as well as the outer edge of each colony was almost white.

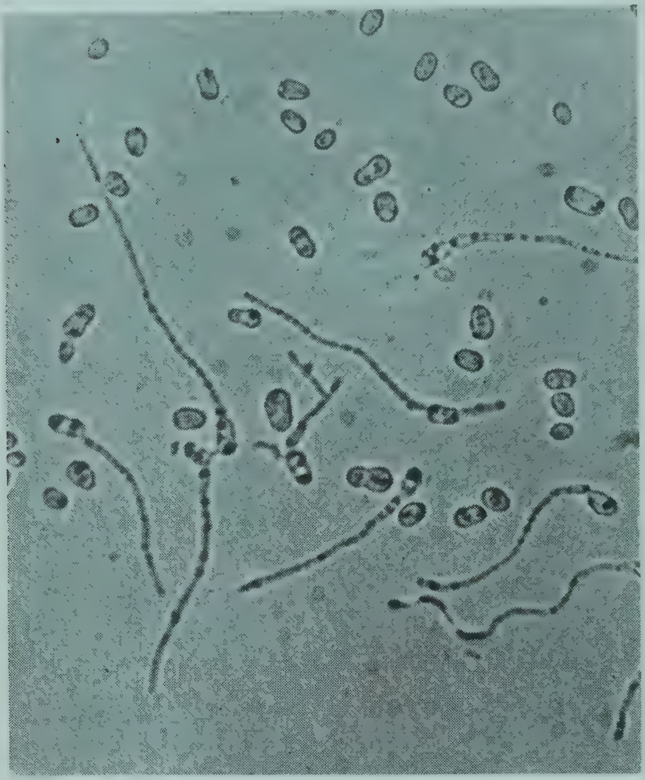

Fig. 16.—Germination of spores of *Phyllosticta sorghina* in 1% sucrose solution after 20 hours. The spores are now much swollen. Note budding in yeast-like fashion, as well as germ tube formation. (X 450.)

Abundant pycnidia and spores were found in the light and dark, no difference in these respects being detectable.

Because of the difference occurring in pigmentation and zonation by colonies of *P. sorghina* in the light and darkness, a further experiment was made with the cultures after the five-day exposure to the two conditions. Two plates from the dark were placed in diffuse light on the laboratory table, while two plates from the light were placed in the dark can. The remaining four plates in each case were left in their original locations for controls.

After four days it was found that the two plates removed from the light and placed in the dark, failed to develop any further rings, while the controls in the light formed two more rings during the period. In the case of the two plates removed from the dark and placed in the light, rings were very evident and a definite pink pigmentation had developed. The controls left in the dark showed no zonate rings or pigmentation.

DISCUSSION OF RESULTS

While no difference of significance in the amount of vegetative growth or reproduction occurred in light or darkness, light was associated with the formation of zonate rings and the development of a pink pigmentation in the case of *P. sorghina* only, after a period of five days. Zonation of *H. ocellum* cultures after prolonged periods of several weeks in the light has been observed, but whether such zonation occurs in cultures grown for such extended periods in the dark has not been determined.

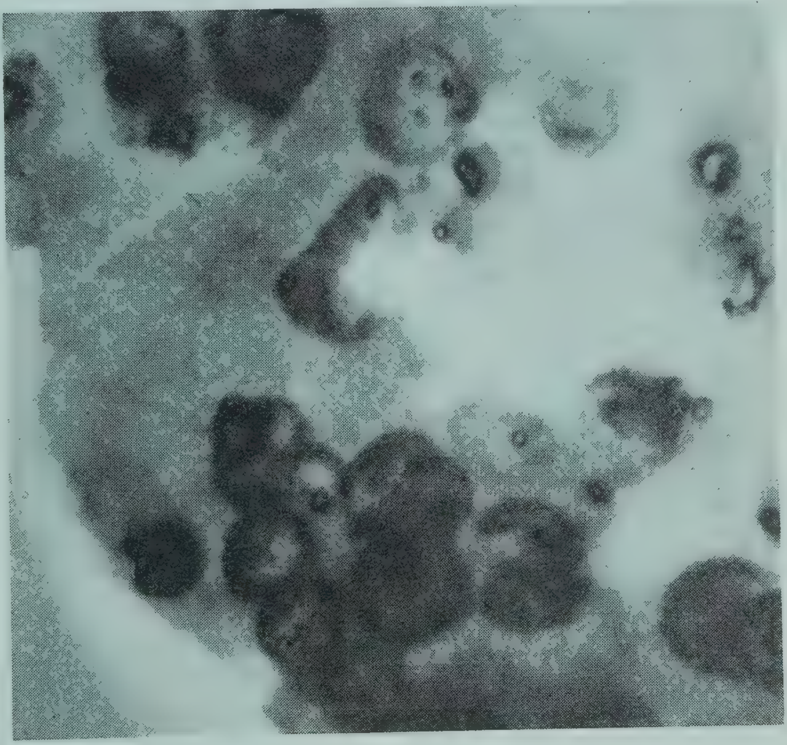

Fig. 17.—Portion of culture of *Leptosphaeria sacchari* (on sterilized cane leaves) after 43 days, showing the pycnidia of the conidial stage, *Phyllosticta saccharicola.* (X 60.)

STUDIES ON NITROGEN FIXATION

As Waksman*(59)* has recently pointed out, careful investigations have established the fact that common soil fungi are unable to fix atmospheric nitrogen. However, few parasitic fungi have been studied with respect to this phenomenon. Since positive fixation has been claimed for *Phoma betae* by Duggar and Davis*(23)* and *P. radicis* by Ternetz*(54)* and because of the artificial nature of the generic segregation of *Phoma* and *Phyllosticta*, it seemed desirable to make tests on the important saprophyte *P. sorghina* as well as *H. ocellum.*

EXPERIMENTAL METHODS

A modified Richard's solution* was employed, using 1% sucrose

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*K_2SO_4—10 grams; KH_2PO_4—5 grams; $MgSO_4$—2.5 grams; $FeCl_3$—20 mgs; Sucrose—10 grams; distilled water—1000 cc. Only C.P. chemicals employed.

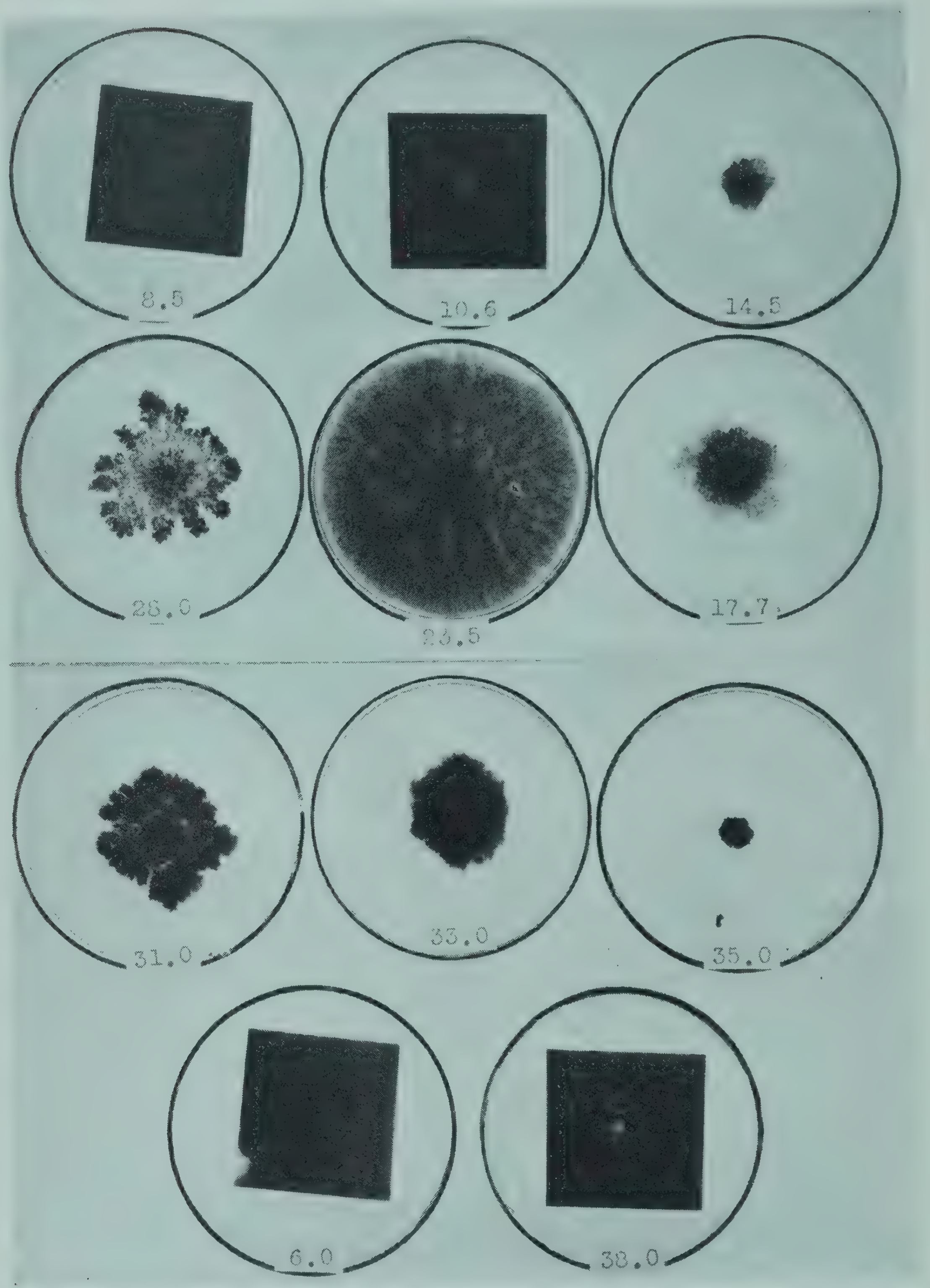


Fig. 18.—Relation of temperature (degrees C.) to growth of *Helminthosporium ocellum* in culture.

(C.P.) as a source of carbon and omitting a source of nitrogen other than that of the atmosphere.

Sixteen 500 cc. pyrex Erlenmeyer flasks were thoroughly cleaned and rinsed in tap and distilled water. After thoroughly mixing the nutrient solution, 250 cc. was placed in each flask and steam sterilized for 10 minutes at 15 pounds. The flasks were incubated for 48 hours to detect contamination and then inoculated with a small loopful of an aqueous spore suspension of the organism selected. Six flasks were inoculated with *H. ocellum*, six with *P. sorghina* and four held as controls without inoculation. All cultures were then placed in diffuse light of the laboratory. The intention was to make total nitrogen determinations of each flask after good growth had been made in the inoculated flasks.

RESULTS

After four weeks at room temperature, a very faint weft of mycelium was visible on the surface of each inoculated flask. The controls were still sterile.

DISCUSSION OF RESULTS

It is evident that *H. ocellum* or *P. sorghina* cannot grow in a nutrient solution free from nitrogenous substances. The conclusion is drawn that the fungi cannot fix atmospheric nitrogen under the conditions of the experiment.

RETENTION OF VIRULENCE OF PARASITE IN CULTURE

The loss of virulence by both parasitic bacteria and fungi has been noted by several workers in the past. Smith*(51)* noted that parasitic bacteria frequently lost their virulence when grown for a long time on culture media and even considered that recovery of the host from disease might be due to this phenomenon. Edgerton et al.*(24)* working with a parasitic species of *Pythium* causing a root rot of sugarcane, showed that the virulence of the fungus becomes much attenuated after a period of two years in artificial culture, Burkholder*(10, 11)*, also found that when the parasite *Fusarium martii phaseoli* is grown in culture (pure) for some time its virulence is considerably reduced, although such an attenuated culture could be restored to normal by growing it for several months on its host, the bean plant.

In April, 1930, *H. ocellum* was isolated from a sugarcane leaf and after single-spore purification, grown in artificial culture until December, 1932, or more than 2½ years. The same strain, subcultured and used for inoculation purposes and reisolated from diseased tissue several times, was used for parallel infection trials

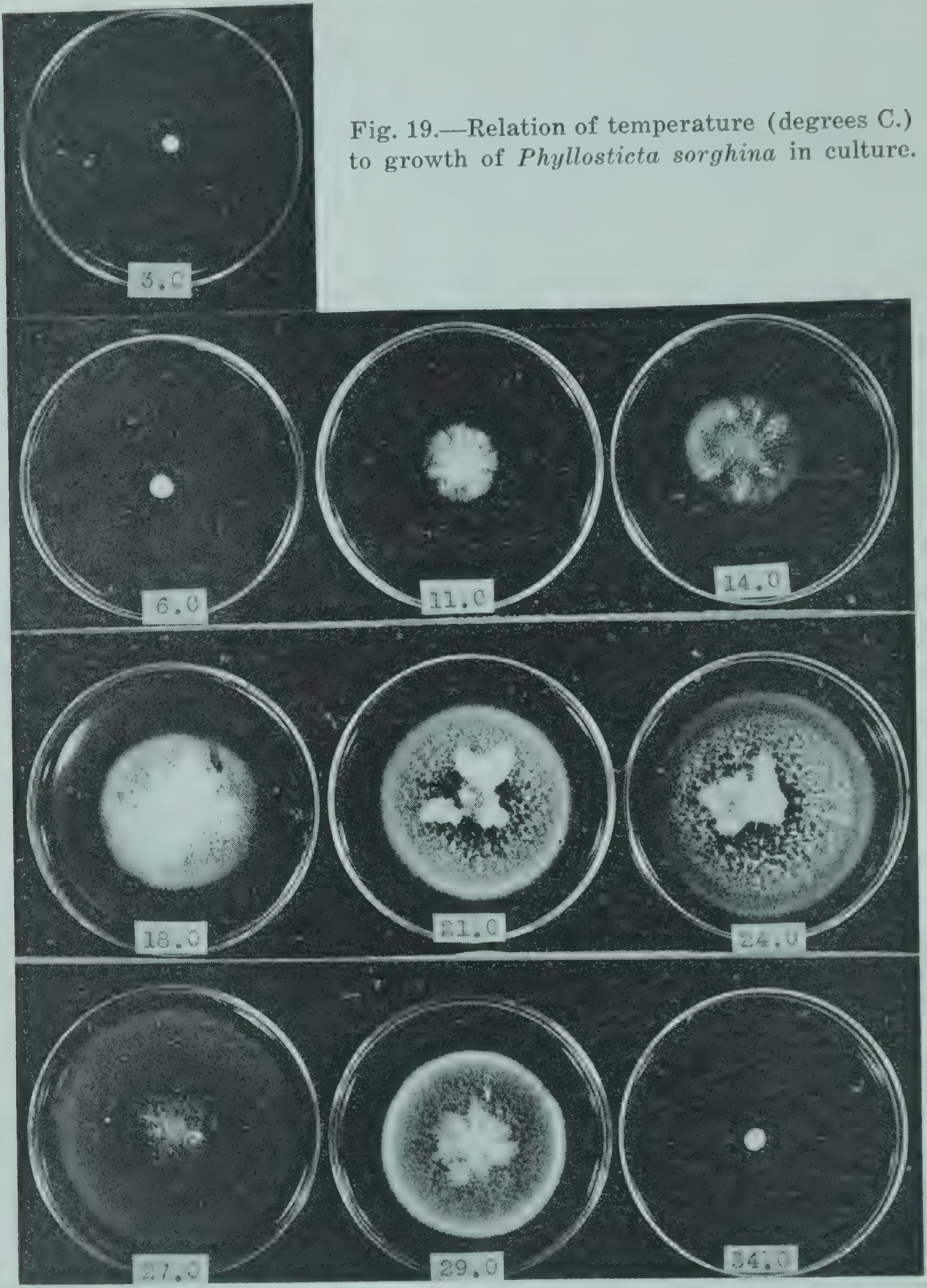


Fig. 19.—Relation of temperature (degrees C.) to growth of *Phyllosticta sorghina* in culture.

for comparison with the culture which had lived saprophytically for 2½ years. Repeated trials showed clearly that the culture after such a long period of saprophytic existence could infect leaves, leaf sheaths and stems just as readily as the strain which had been allowed to live parasitically for various periods.

EXPERIMENTS ON THE PRODUCTION OF TOXIC SUBSTANCES BY THE PARASITE H. OCELLUM

Lee*(39)* in an extensive paper on the toxic substance produced by the eye spot fungus of sugarcane, *H. sacchari* Butler, claims that the wilting of cut cane leaves immersed in filtrates of cultures of the fungus is closely correlated with the presence of nitrites in such filtrates. Further, dilute solutions of potassium nitrite brought about the same reaction of susceptible cane leaves as the filtrates of cultures of the eye spot fungus in media containing the lower nitrogen compounds.

The writer is unable to agree with the conclusions drawn by Lee on the basis of experiments performed. In the first place, the actual concentration of nitrites in various cultures was not determined in a single instance for comparison with the artificial concentrations arbitrarily tried and found to be toxic. Further, although no nitrites could be detected in the peptone medium on which *H. sacchari* grew, the cane leaves wilted decidedly before the controls, strongly indicating that some factor other than nitrites might have been involved in the wilting phenomenon.

During the physiological studies on *H. ocellum*, the formation of magnesium ammonium phosphate in considerable quantities from certain cultures, e. g. peptone and blood fibrin, led the writer to suspect that perhaps ammonia or ammonium compounds might be involved in the toxic action of the fungus. In fact, when grown for 25 days on White's*(60)* modified Richard's solution containing 2% peptone, only traces of nitrites could be detected, whereas tests for nitrogen as "free ammonia" showed 1,000 parts per million in the filtrate. It was therefore decided to test the toxicity of filtrates of cultures of *H. ocellum* to cane leaves and to make quantitative determinations of both nitrites and nitrogen as "free ammonia" in these cultures at the time of test.

EXPERIMENTAL METHODS

A modified Richard's mineral solution was made up as follows: KNO_3 24 grams; KH_2PO_4 4 grams; $MgSO_4$ 2 grams; $FeCl_3$ 96 mgs; distilled water, 4,800 cc. This was divided into four equal parts and the following added to each part separately: A, gelatin 24 gms.; B, casein 20 grams; C, blood fibrin 20 grams; and D, sucrose 24 grams. Each part was then divided into 200 cc. portions in 500 cc. Erlenmeyer flasks, steam sterilized, incubated for 4 days to detect contamination and half the number of flasks

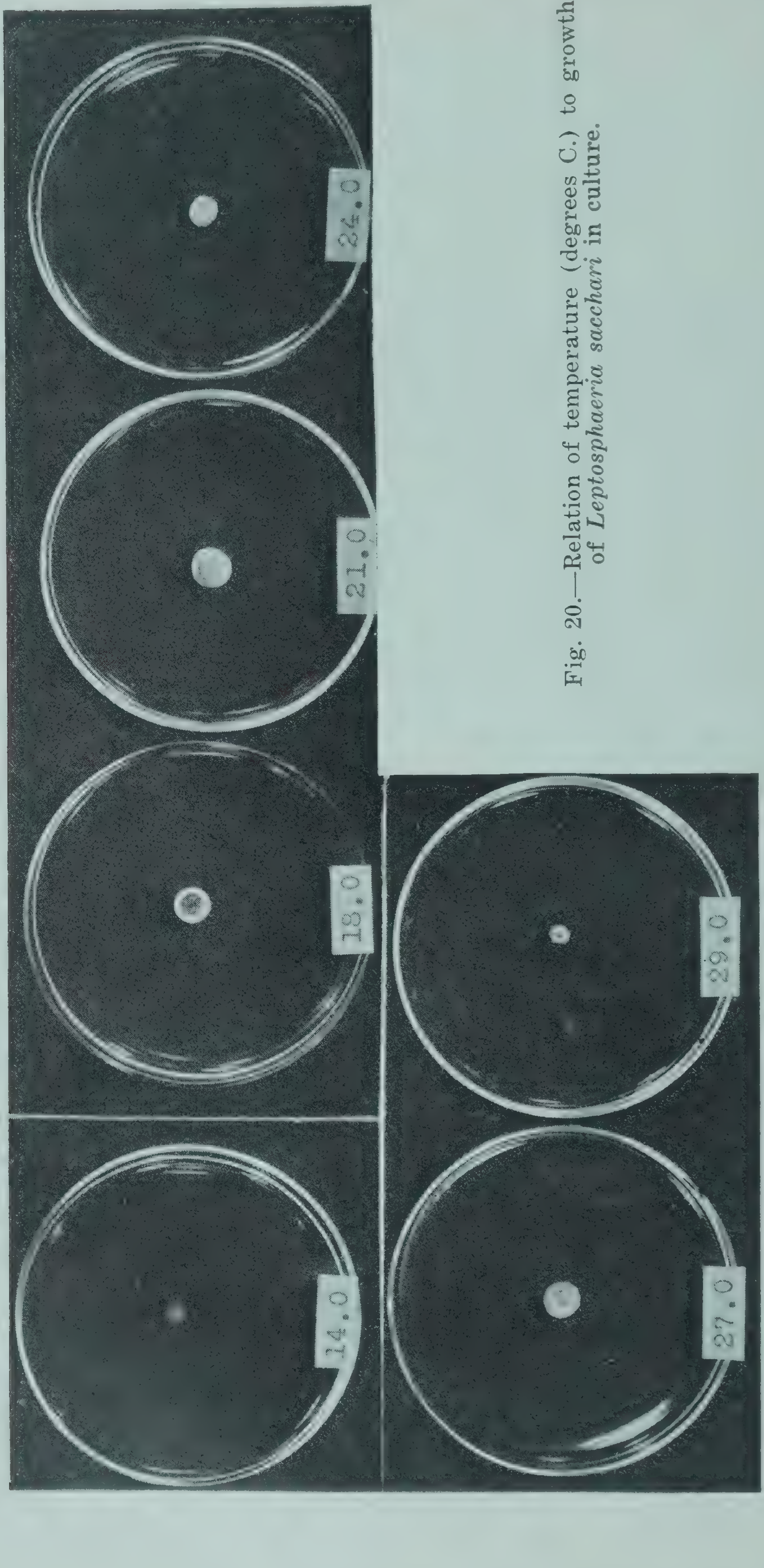


Fig. 20.—Relation of temperature (degrees C.) to growth of *Leptosphaeria sacchari* in culture.

of each kind inoculated with a loop of spores of *H. ocellum.* At the end of varying periods, as shown in Table IX, the filtrate of each part containing a specific source of carbon was tested for toxicity to freshly cut outer leaves of Otaheite cane, after filtration through a steam sterilized Berkefeld filter. At the same time, quantitative determinations were made for nitrites and nitrogen as "free ammonia" according to the methods described by Mason*(44)*. In each series of toxicity tests, 12 wide mouth bottles thoroughly cleaned were used. Three bottles were used for the full concentration of fungus filtrate, three for 50% concentration of filtrate diluted with distilled water, three for uninoculated culture medium and three for distilled water, all being set up at the same time for comparison.

RESULTS

In not a single instance did wilting of the leaves occur until after the cultures became cloudy due to bacterial action, which almost invariably occurred in the nutrient cultures 24 to 48 hours after the experiment was set up. The writer has therefore been unable to detect any significant toxic action of the filtrate of *H. ocellum* on any of the substrates tested, either in the form of wilting of the leaves due to collapse of the motor cells or by the discoloration of tissues.

The chemical tests of the filtrates used are reported in Table IX.

TABLE IX.—QUANTITATIVE RESULTS OBTAINED FOR NITRITES AND NITROGEN AS "FREE AMMONIA" IN FILTRATES OF CULTURES OF H. OCELLUM GROWN ON MODIFIED RICHARD'S SOLUTION WITH VARIOUS SOURCES OF CARBON.

Medium No.	Carbon Source	Age of culture (days)	Nitrogen as nitrite. p.p.m.	Nitrogen as "free ammonia". p.p.m.
A	Gelatin	34	0.3	300.0
B	Casein	35	0.0	300.0
C	Blood fibrin	38	0.0	300.0
D	Sucrose	40	Trace	25.0

DISCUSSION OF RESULTS

The results show that *H. ocellum* does not produce nitrites in culture in sufficient quantity to even arouse suspicion that this chemical is of importance as far as the toxic action of the fungus is concerned. On the other hand, depending on the amount of KH_2PO_4 and $MgSO_4$ used in the cultures containing certain protein substances, nitrogen as "free ammonia" may amount to as much as 1,000 parts per million. The possibility of the fungus liberating free ammonia in toxic quantities in the living tissues is therefore considered to be of sufficient significance to warrant further study.

It should be borne in mind, however, that the toxic action of the fungus in the tissues can be explained from other angles. The fact that the fungus requires nitrates or some source of nitrogen other than from the atmosphere for its metabolism means that the removal of this element from the invaded cells upsets the physiological balance and undoubtedly hinders further synthesis of complex nitrogenous compounds. The pronounced action of invertase is especially significant and indicates that this readily soluble enzyme may diffuse out in advance of the growing mycelium and invert sucrose produced synthetically in the leaf tissue.

GENERAL DISCUSSION OF CERTAIN PHYSIOLOGICAL PHASES OF THE RING SPOT PROBLEM

It has been shown that true ring spot symptoms as previously described by most authors are brought about by the action of certain saprophytic fungi which follow the primary pathogene *Helminthosporium ocellum*. Among these, *Phyllosticta sorghina* has been shown to be especially active, even to the point of causing lesions of the pathogene under certain conditions to develop more rapidly than when absent.

The ability of *P. sorghina* to tolerate a greater intensity of alkalinity in the medium would appear to be of significance in relation to its favorable association with *H. ocellum*. Both fungi, because of their pronounced ability to form ammonia from certain higher protein substances and their derivatives, tend to create an alkaline environment especially unfavorable to the growth of the pathogene. It is true that heavy dews and rain undoubtedly leach out unfavorable by-products from the plesionecrotic and holonecrotic portions of the lesions, but *P. sorghina* nevertheless can continue to destroy more effectively these tissues even after the action of the pathogene has been almost inhibited by an increase in alkalinity of the substrate.

Since the optimum temperature for the growth of *H. ocellum* has been found to be 23.5°C. and that for *P. sorghina* 27.0°C., it is obvious that temperature conditions are more favorable for the growth of the saprophyte during a considerable part of the 24 hour cycle in Florida, even during the cool months of the year.

The fact that *H. ocellum* passes directly through the wall of

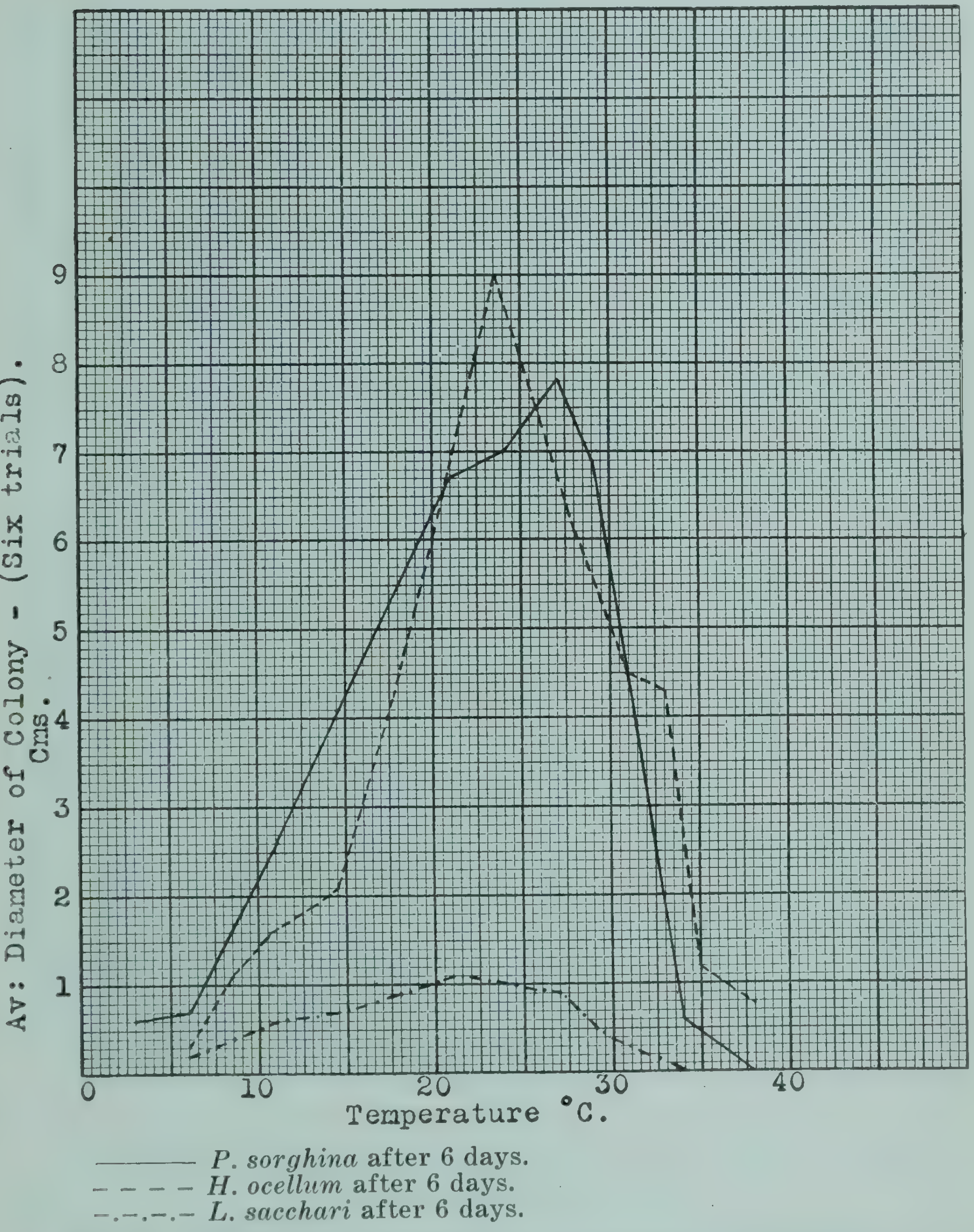


Fig. 21.—Graphical representation of the relation of temperature to the growth of *H. ocellum, P. sorghina* and *L. sacchari* in culture. All measurements made after six days.

the epidermis, especially in the case of the motor cells of the leaf, and also travels through the cell walls of the sub-epidermal tissues, suggests that the thickening of these walls might be a primary factor in resistance or immunity of certain varieties to the disease. The application of nitrogenous fertilizer has been noted to have a marked correlation with increase in susceptibility of the host. Since nitrogen as a factor in plant nutrition has been shown by Thatcher*(55)*, Russell*(48)* and others to produce a marked growth of soft sappy tissue having thinner walls, it becomes evident that resistance may be largely a mechanical phenomenon, although changes in the composition of the cells as regards food materials, hydrogen-ion concentration and osmotic pressure undoubtedly play a role of special importance.

CONTROL

Since the eye spot and its later stage, the ring spot, are well established in practically every sugarcane country of the world, and the parasite is capable of living saprophytically for more than 2½ years without loss of virulence, attention must be directed to the protection of the existing host varieties from infection, or to the breeding of new types resistant or immune to the malady.

The same correlation between the virulence of the disease and nitrogen nutrition as has been observed for eye spot in Hawaii by Lee*(39)* has been observed in Florida. The disease has never been observed to be severe on sandy or clayey soils rather deficient in nitrogen. On the other hand, in sections of the Florida Everglades where cane is grown on peat and muck lands having a high total and at times a very available supply of nitrogen, the disease often assumes a role of considerable importance. The practical control measure mentioned by Lee*(39)*, whereby nitrogenous fertilizers are avoided during seasonal periods in which climatic conditions favor fungus infection—during the cool fall and winter months in Florida when temperatures approach the optimum of 23.5°C. for the pathogene—is of course only possible in regions where the nitrogen supply can be controlled. In sections of the Florida Everglades where the control of the nitrogen content of the soil is impossible, use of resistant or immune varieties is the only practical solution to the problem.

THE BREEDING OF VARIETIES RESISTANT TO THE DISEASE

No information has been available in the literature to show the most desirable mode of attack in the problem of breeding for resistance to this disease. It is true that many varieties of the true sugarcane group *Saccharum officinarum* have shown very serious susceptibility to the malady, indicating that attention should be directed toward observation on and possible use

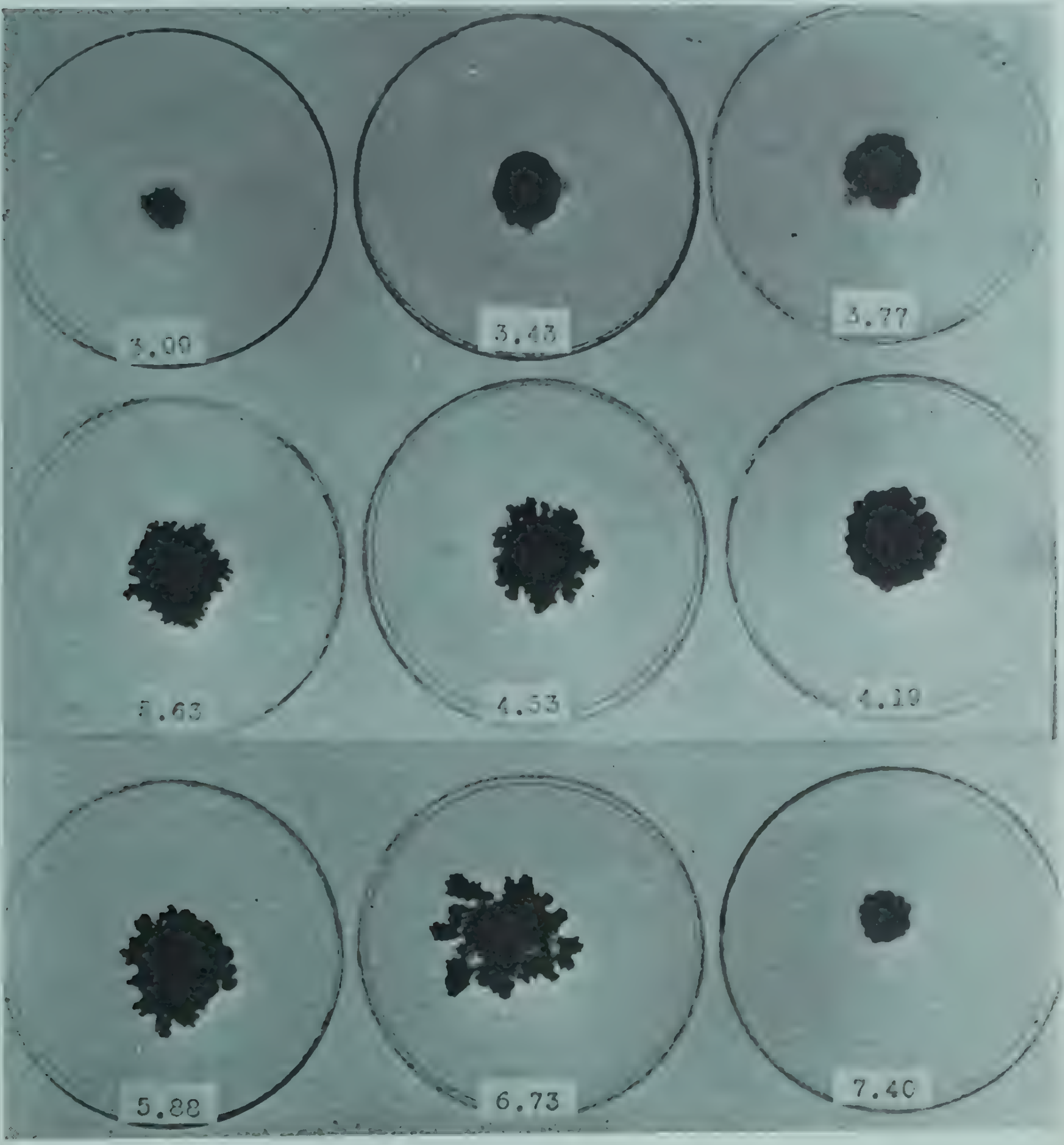


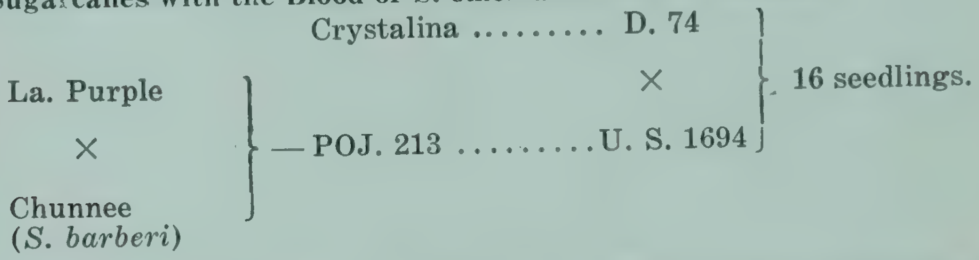
Fig. 22.—Relation of pH of medium to growth of *H. ocellum*. Photo after 10 days at approximately 28°C.

of certain varieties of other species of *Saccharum*, such as *S. spontaneum* (wild cane) or *S. barberi*, in a program of breeding for resistance or immunity. The fact that certain *saccharatus* varieties of *Holcus sorghum* are apparently immune to the disease under conditions in the Florida Everglades, also suggests the desirability of investigating fully the possibilities of the intergeneric hybridization of *Saccharum* and *Holcus*.

During the past seven years, the writer has conducted extensive breeding experiments with sugarcane varieties in a section of Florida where the ring spot is most prevalent and has therefore had an unusual opportunity to study the disease among progeny from many different combinations. While relatively few intergeneric hybrids between sugarcane and sorghum have been produced for study, the results are not without interest.

The more important combinations which have been studied, together with the number of progeny which have been under observation in each case and their genealogical history are presented below, together with a brief discussion of the nature of the results secured. The parentage of the Javanese canes has been secured from the published work of Jeswiet*(34)* and Bannier*(8)* and that of the Indian varieties from Venkatraman and Thomas*(57)*.

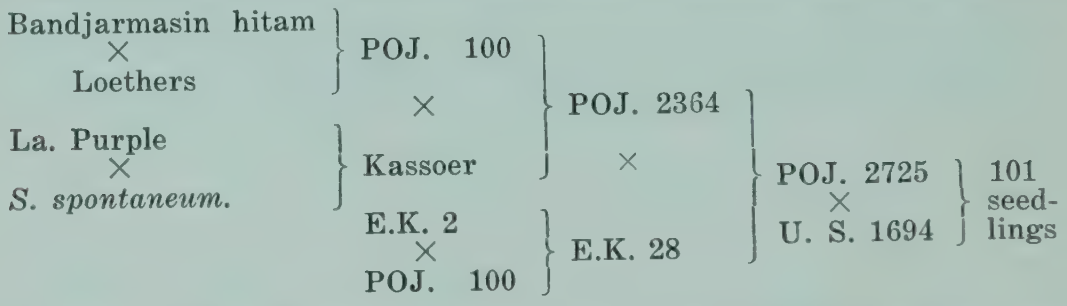
A. Sugarcanes with the Blood of S. officinarum and S. barberi.



The number of progeny studied is too few to form any idea as to the direct value of this combination. Nevertheless, some of the seedlings e. g. CP. 27-34, 35 and 38 have shown a satisfactory resistance to ring spot and have been used for further crosses with promising results, largely because of the desirable early blood of D. 74.

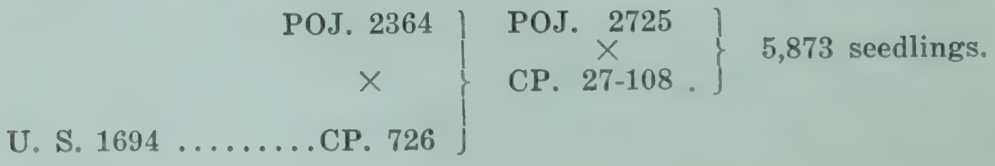
B. Sugarcanes with the Blood of S. officinarum, S. barberi and S. spontaneum.

1.



Although only a few progeny have been studied, it has been noted that moderately susceptible varieties are to be found in this group, e. g. CP. 27-139, undoubtedly due to the marked susceptibility of POJ. 100 in the ancestral lineage. On the other hand, an equal number of progeny appeared to be very resistant, e. g. F. 29-7, so that the combination has proved a valuable one for securing resistant types under a system of rigid selection.

2.



Such a large number of progeny of this combination have been studied that a definite opinion can be rendered as to its value. Most of the seedlings showed marked resistance to the disease and some of the most promising agricultural types are at present included here, e. g. F. 30-16, 20, 26, 35, 89 and others.

3. POJ. 2725
D. 74 × 2,800 seedlings.
× CP. 27-35
U. S. 1694

The number of progeny studied has been adequate for judging the merits of this combination. The majority showed marked resistance to the disease and in addition this cross has given the largest stalked and apparently the most desirable agricultural types so far developed, e. g. F. 31-407, 425, 426, 566, 572, etc., which are now in the process of agronomic trials.

4. POJ. 2725
D. 74 × 3,496 seedlings.
× CP. 27-34
U. S. 1694

The majority of the progeny showed marked resistance to the disease, but otherwise this combinaton was definitely inferior from an agricultural standpoint to No. 3, where the brother variety CP. 27-35 was used.

5. La. Purple
× POJ. 213
Chunnee
× Co. 281
Ashy Mauritius
×
Co. 206
S. *spontaneum* × 763 seedlings.
POJ. 2364
× CP. 27-108
CP. 726

The majority of the progeny were highly resistant and some practically immune to the disease. Further, this combination is one of the few involving the early maturing Co. 281 which has given indications of a good proportion of satisfactory commercial types for selection.

6. La. Purple
× } POJ. 213
Chunnee
× } Co. 281
Ashy Mauritius
× } Co. 206
S. spontaneum
× } 797 seedlings.
POJ. 213 — U. S. 1964

This combination has given rise to progeny a large number of which are very susceptible to the disease. Practically all of the seedlings are thin stemmed, "grassy" and unattractive from the standpoint of commercial utilization for sugar making.

Certain facts stand out clearly as a result of the breeding work with sugarcane varieties so far conducted. The most desirable combinations from the standpoint of proportion of resistant progeny, combined with indications of satisfactory commercial habits are: POJ. 2725 x CP. 27-35, POJ. 2725 x CP. 27-108 and Co. 281 x. CP. 27-108. It is also significant that those combinations involving a high proportion of Chunnee (*S. barberi*) blood have given rise to a greater degree of susceptibility among the progeny, whereas those having a high proportion of *S. spontaneum* blood have given seedling populations markedly resistant to the disease.

With reference to the *Saccharum* x *Holcus* hybrids, only about 30 of these have been under observation, which number is rather limited for an adequate study. The hybrids consist of about an equal number of progeny of crosses between POJ. 2725 sugarcane and the *Holcus sorghum saccharatus* varieties Texas Seeded Ribbon and Kansas Orange. While certain types, e. g. F. 31-61, are showing marked resistance to the malady, others, e. g. F. 31-8, are proving to be rather susceptible, indicating that rigid selection will have to be made from progeny of such intergeneric combinations if their utilization is intended either for the Florida Everglades or for locations having environmental conditions favorable for the development of the disease.

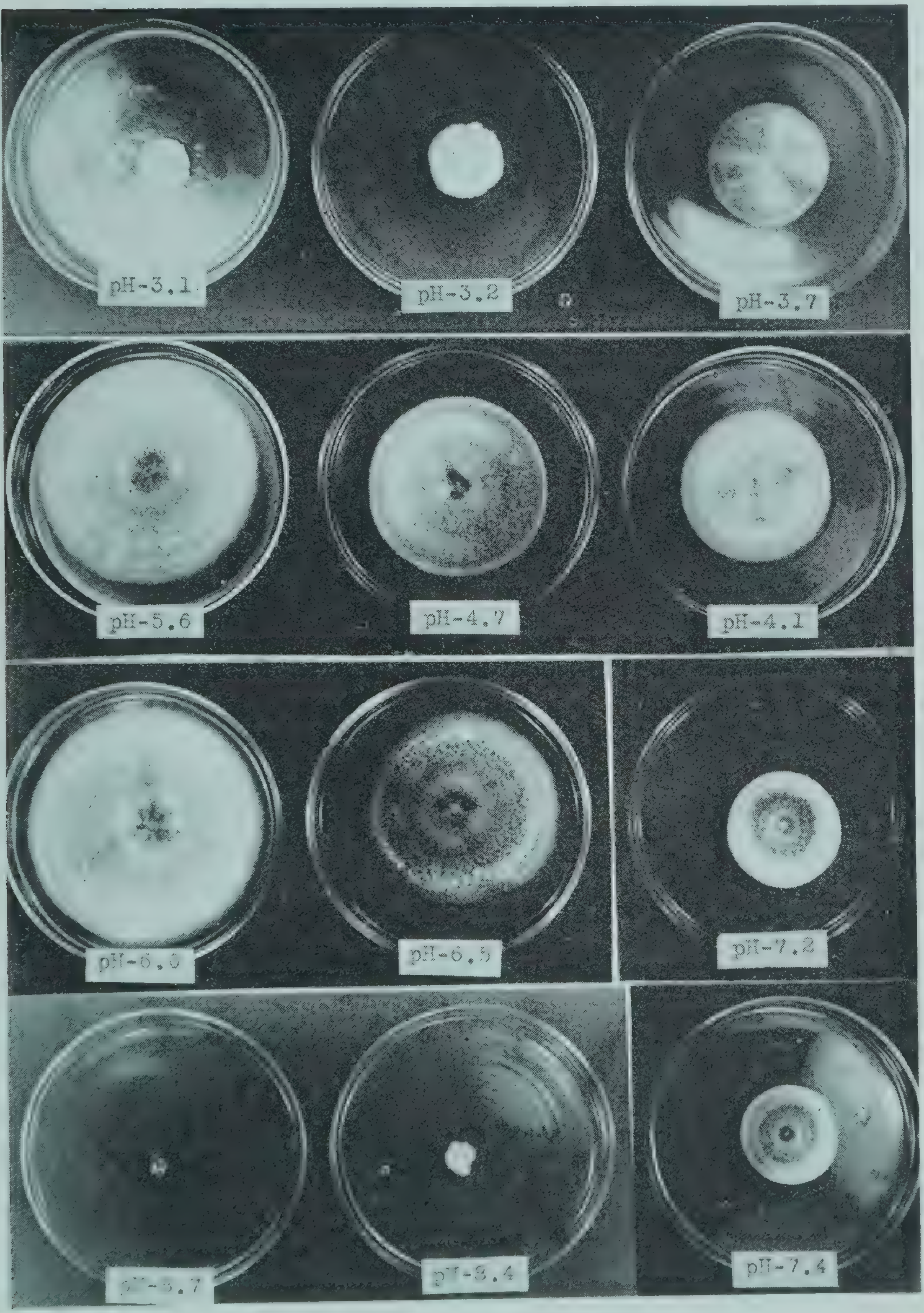


Fig. 23.—Relation of pH of medium to growth of *P. sorghina*. Photo after six days at approximately 28°C.

SUMMARY

1. The names, history and geographical range of the ring spot disease are reviewed. The economic importance from the standpoint of commercial canes and the breeding of new varieties is discussed.

2. The morphologic and histologic symptoms of the disease on leaves, leaf sheaths and stems are given.

3. A summary of the organisms associated with the disease in nature and their relative frequency of occurrence is recorded.

4. A review of the etiological history of the disease is given. Proof is furnished that *Helminthosporium ocellum* Faris is the primary cause of the disease, whose lesions at first are identical with eye spot. Later, with the development of such saprophytes as *Phyllosticta sorghina* Sacc. and *Leptosphaeria sacchari* van Breda de Haan, the ring spot symptoms are brought out.

5. There is some evidence that a mixture of *H. ocellum* and *P. sorghina* develop lesions more rapidly under certain conditions than *H. ocellum* alone.

6. The names, history and classification of the parasite are given and the life-history is discussed. The organism is seen to gain entrance into the leaf directly through the epidermal wall, especially in the case of the motor cells. Entrance also occurs through stomates. The mode of entrance into sheath and stem portions is accomplished in a manner similar to that of the leaf.

7. The most important and frequently associated saprophyte, *P. sorghina*, is discussed from the standpoint of names, history and classification. Its occurrence on several other hosts, e. g., *Panicum maximum*, *Panicum dichotomiflorum*, *Panicum* sp. and *Holcus sorghum* is recorded in association with similar ring spot lesions due to other fungi.

8. The life-history of *Leptosphaeria sacchari* is reviewed and proof given for the genetic connection between *Phyllosticta saccharicola* Henn. and the perfect stage.

9. The comparative susceptibility of a number of commercial and other sugarcanes is recorded for Florida.

10. The physiology of both *H. ocellum* and *P. sorghina* as regards the relation of temperature, pH of medium and light; growth on different sources of carbon; enzymes produced; relation to associated organisms and to each other and nitrogen fixation is given. The optimum temperature for the development

of the parasite in culture has been shown to be 23.5°C. The virulence of this organism is seen to be maintained unchanged even after 2½ years under saprophytic conditions.

11. In toxicity studies with filtrates of *H. ocellum* on several media, no significant wilting of the leaves was secured. Among the substances produced in suspicious quantities, magnesium ammonium phosphate deserves special mention and this suggests the production of ammonia in toxic quantities in the host tissue.

12. The host range has been extended from varieties of *Saccharum officinarum* to include hybrids having the blood of *S. officinarum, S. spontaneum* and *S. barberi.* Further, although *Holcus sorghum* varieties Texas Seeded Ribbon and Kansas Orange appear to be immune, a number of intergeneric hybrids between them and sugarcane have proved to be susceptible to the disease.

13. Breeding experiments for the production of resistant and immune varieties, covering a period of seven years, are briefly reviewed. The genealogical histories of some of the most favorable and unfavorable breeding combinations yet investigated are recorded. Combinations having a high proportion of Chunnee (*Saccharum barberi*) blood have given rise to a greater degree of susceptibility among the progeny than those having a high proportion of *Saccharum spontaneum* blood, the seedling populations of which show a marked resistance to the disease.

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THE PECTIC CONSTITUENTS OF CITRUS FRUITS

By L. W. Gaddum

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THE PECTIC CONSTITUENTS OF CITRUS FRUITS

By L. W. GADDUM

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INTRODUCTION

The pectic compounds comprise primarily the gelatinizable substances having their origin in plant cell walls and are characterized chemically by the presence of a galacturonic acid nucleus in the molecular structure. They form the main constituent of the middle lamellae of plant cells*(1)*,*(8)*,[1] and are intimately involved both in the normal ripening of fruits*(2)*,*(6)*,*(8)*,*(9)*,*(15)*,*(19)*,*(25)*,*(33)* and in some pathologic changes due to microorganisms*(8)*,*(24)*,*(27)*,*(30)*,*(40)*.

Three types of pectic compounds are recognized:[2]

(1) Pectic acids, which are insoluble in water and contain no methoxyl groups.

(2) Pectins, which are methyl esters of pectic acids and are soluble in water.

(3) Protopectins, which are the water-insoluble, acid-hydrolyzable parent substances of the pectins and are present in the cell-walls of plants, possibly in combination with cellulose*(36)*. Normal ripening processes (and sometimes pathologic processes) are accompanied by a gradual transition from the insoluble protopectins to the soluble pectins with a consequent decrease in cell-wall rigidity. The transition terminates finally in demethylated pectic acids so that over-mature fruits will sometimes contain practically no pectins.

The literature arising from a century of study of pectic compounds has been adequately summarized elsewhere*(4)*,*(5)*,*(10)*,*(11)*,*(28)*,*(34)*, and consequently a comprehensive resumé of the literature need not be given here. It is of interest, however, to note certain trends which the study of pectic compounds seems to be following at the present time.

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[1] Figures in parentheses (Italic) refer to "Literature Cited" in the back of this bulletin.

[2] Report of the committee on the nomenclature of pectin, of the Agriculture-Food Division of the American Chemical Society. Sept. 6-11, 1926.

The suggestions for a chemical structure of pectic acid, the basic unit of the pectins, seem to have crystallized into two alternatives—the arabinose-galactose-galacturonic acid ring formula of Nanji, Paton and Ling*(23)* and the arabinose-galactose-tetragalacturonic acid formula of Ehrlich*(3)*,*(12)*,*(13)*,*(14)*. On the basis of the Nanji, Paton and Ling theory, a completely demethylated pectin (i. e. pectic acid) would have the empirical formula $(C_{35}H_{50}O_{33})x$; according to Ehrlich, the completely demethylated pectin from sugar-beets would have the formula $(C_{41}H_{58}O_{37})$ and that from orange peels would have the formula $(C_{39}H_{56}O_{36})$. According to these two theories, the pectins of varying degrees of methylation should contain, theoretically, the methyoxyl percentages shown below.

	Mono-methylated	Di-methylated	Tri-methylated	Tetra-methylated
Nanji, Paton and Ling	3.06	6.04	8.94	11.76
Ehrlich (sugar beet pectins)	2.68	5.29	7.85	10.35
Ehrlich (orange peel pectins)	2.78	5.49	8.14	10.73

The percentage of calcium in calcium pectate should, according to these theories, have the following values:

Nanji, Paton and Ling	7.45
Ehrlich (sugar beet pectins)	6.57
Ehrlich (orange peel pectins)	6.78

These theoretical values will be discussed later in connection with experimental data on citrus pectins.

A great amount of study has been devoted also to the physical properties of the pectic compounds. The viscosity and jellying power of various fruit pectins have received much attention in recent years because of the bearing of these properties on the commercial evaluation of the pectins. This work will be discussed in connection with the data to which it may be pertinent.

Of the three types of pectic compounds, the pectins alone have been found of commercial value. The use of the pectins is based primarily upon the three characteristics: (1) their jellying properties, (2) their colloid stabilizing properties, and (3) their power of water imbibition. These characteristics are profoundly affected by the maturity of the fruit used as source, and by the method of extraction*(17)*,*(20)*,*(21)*,*(22)*. Work was therefore planned to study the effect of maturity and fruit type on the chemical composition and physical properties of the pectins extracted from different tissues of citrus fruits.

PLAN OF INVESTIGATION

Since the method of extraction influences profoundly the amount and nature of the pectic materials extracted, it is necessary to employ a uniform extraction method in the study of maturity and other factors. To this end, the effect of pH, temperature, and time on the yield and quality of extracted pectins was studied to determine the method of extraction chosen to be used throughout the work.

To consider the distribution of pectic compounds among the tissues of the fruit, the fruit was dissected and the various portions extracted separately. The moisture, protopectic and total pectic contents of the different tissues were then determined by methods discussed below. Those properties of the extracted pectins which are concerned in the commercial use of these pectins were compared for three different fruits (grapefruit, orange, kumquat). To obtain some indication of any fundamental chemical variations among citrus pectins, some study was given to the pectic acids obtained from the extracted pectins.

EXTRACTION METHODS

Myers and Baker*(22)*, basing their work on the pioneer work of Tarr*(37)*, have shown the importance of the pH control in the extraction of pectins as well as in the manufacture of jelly from pectins. Accordingly, the pH of the extraction medium, the temperature, and the duration of the extraction process were chosen as the dominant variables.

The material to be extracted was dried in vacuo at 60°C., ground to pass a 100 mesh sieve, and then thoroughly mixed to provide homogeneous samples.

Since the extracted pectins are subject to hydrolysis by continued action of the solvent, it was necessary to reduce the time of action of the solvent on the extracted pectins to a minimum. Accordingly the following procedure was adopted: 10 grams of sample were treated with 600 ml. of solvent*(22)* with rapid stirring at the chosen temperature for 10 minutes; the mass was then filtered through several layers of silk; as much of the solvent as possible was pressed from the mass. The extracted pectins were then removed from the filtrate as discussed below. The sample residue remaining from the filtration was submitted to the above extraction process a number of times in succession, the extracted pectic compounds being each time removed from the filtrate.

The hot filtrate from each of the above extractions was poured into chilled alcohol (below 15°C.) and immediately cooled below 15°C. The precipitated pectin was filtered off, dissolved in water, reprecipitated twice with alcohol, filtered with suction, washed with alcohol and then with ether, and finally dried to constant weight in vacuo at 60°C. The dried pectic material was then ground to pass a 100 mesh sieve and analyzed for methoxyl content by the method of Zeisel, for pectic acid content by the modified method of Carre and Haynes*(7)*,*(16)*, and for ash content.

To determine the effectiveness of the above extraction method, a series of experiments were run on samples of lemon, grapefruit, and orange albedoes. The results for the extraction of lemon albedo are shown in Table I; the results for the grapefruit and orange albedoes were practically the same as those for the lemon albedo.

In the extraction of pectins from the tissues, several factors come into play: the imbibition of water and subsequent solution of the cell-wall pectins, the hydrolysis of the dissolved pectins and the hydrolysis of the cell-wall protopectins.

Table I shows that, for a given pH, an increase of temperature increases the quantity of pectins extracted. However, the quality of the extracted pectins deteriorates with increasing temperature, as shown by the decrease in the ratio of methoxyl percentage to pectic acid percentage.

Table I shows also considerable variation in the sum of the pectic acid percentage and the methylene equivalent of the methoxyl percentage. Since the calculations of Table I are on an ash-free basis, the sum would approximate 100 percent if the pectins were chemically pure. In reality, however, the values range from 74 percent to 93 percent. Norman*(26)* found that pectin from lemon juice, after five reprecipitations, contained over 20 percent of some impurity which he did not identify. It is of interest in this connection to note that Myers and Baker*(22)* were employing pectins containing from 10 percent to 15 percent impurities when they found no correlation between jellying power and degree of methylation.

To obviate, to some extent at least, the errors due to impurities (other than ash), the ratio methoxyl percentage to pectic acid percentage was calculated. The values shown in Table I for this ratio indicate that the pectins extracted at pH values from 2.0 to

TABLE I.—DATA SHOWING THE EFFECT OF pH, TEMPERATURE AND TIME ON THE EXTRACTION OF PECTINS FROM LEMON ALBEDO.

Solvent	Temp.	Extracted pectic compounds (% of sample)								% pectin in extract					
		1*	2	3	4	5	6	7	8	1	2	3	4	5	6
Distilled	60°C	4.75	3.26	2.91	1.61	1.43	1.06	0.77	0.43	93.10	93.27	92.84	93.14	......	......
water	95°C	9.76	3.31	2.46	1.53	1.27	0.38	0.11	....	92.70	93.35	92.86	92.32	92.34	91.36
pH=4.6	boiling	10.37	4.18	2.19	1.82	0.35	0.10	....	....	92.86	92.26	92.42	92.40	......	92.58
HCL	60°C	5.11	2.75	3.17	1.83	0.96	1.05	0.36	0.12	90.21	89.97	......	90.05	......	......
solution	95°C	11.25	3.23	2.67	1.90	0.84	0.17	0.14	....	87.49	87.54	87.14	87.53	87.51	87.25
pH=3.6	boiling	12.43	4.27	2.81	1.64	1.02	0.36	0.11	....	87.56	87.54	86.64	87.17	87.17	......
HCL	60°C	8.64	3.16	1.23	1.60	0.97	0.82	0.13	0.11	88.35	89.06	......	88.79	......	......
solution	95°C	14.36	4.34	1.72	1.23	0.56	0.12	....	....	82.55	82.47	82.27	82.07	82.37	82.16
pH=3.0	boiling	15.21	5.63	2.34	0.97	0.21	0.10	....	....	82.20	82.36	......	82.30	......	82.13
HCL	60°C	9.74	4.21	0.93	1.27	0.72	0.91	0.20	....	85.07	......	86.03	......	......	81.32
solution	95°C	20.13	4.13	1.37	0.92	0.31	0.11	....	....	75.01	74.45	74.63	74.01	......	74.10
pH=2.6	boiling	19.69	7.30	3.72	1.64	0.53	....	....	....	75.62	74.96	75.10	74.25	74.44	......
HCL solution	95°C	20.47	5.13	2.25	1.30	0.21	0.10	....	....	82.45	82.50	82.15	82.01	82.18	82.18
pH=1.9	boiling	22.39	9.77	1.36	0.10	....	....	....	....	81.44	......	81.57	......	......	......
HCL solution	95°C	20.73	6.12	2.32	1.27	0.23	0.51	0.13	....	85.63	......	85.55	......	......	......
pH=1.2	boiling	20.15	8.93	2.10	0.93	0.37	0.12	....	....	85.59	......	......	84.91	......	84.52
HCL solution	95°C	12.11	3.74	0.92	0.14	0.12	....	....	....	85.94	85.75	86.20	85.83	......	......
pH=0.3	boiling	10.91	4.73	0.80	1.03	0.75	0.51	....	....	86.20	87.03	......	85.87	......	......

*The figures indicate successive extractions.

TABLE I.—DATA SHOWING THE EFFECT OF pH, TEMPERATURE AND TIME, ON THE EXTRACTION OF PECTINS FROM LEMON ALBEDO.—(Continued.)

Solvent	Temp.	% pectic acid in extracted pectins						% methoxyl in extracted pectins						Ratio % methoxyl / % Pectic acid					
		1*	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Distilled	60°C	87.49	87.43	87.20	87.56	.....	.....	12.86	12.44	12.47	12.35	.....	.....	0.147	0.148	0.143	0.141	.....	.....
water	95°C	87.15	87.72	87.41	86.98	87.03	86.03	12.29	12.46	12.06	11.83	11.75	11.81	0.141	0.142	0.138	0.136	0.135	0.137
pH=4.6	boiling	87.30	86.85	86.92	87.05	.....	87.16	12.31	11.98	12.17	11.84	.....	12.01	0.141	0.138	0.140	0.136	.....	0.138
HCL	60°C	84.23	84.08	.....	84.34	.....	.....	13.23	13.08	.....	12.65	.....	.....	0.157	0.155	.....	0.150	.....	.....
solution	95°C	82.15	82.23	81.92	82.43	82.31	82.20	11.83	11.68	11.55	11.29	11.52	11.18	0.144	0.142	0.141	0.137	0.140	0.136
pH=3.6	boiling	82.11	82.13	81.46	82.07	81.88	81.50	12.07	11.99	11.48	11.30	11.71	.....	0.147	0.146	0.141	0.138	0.143	.....
HCL	60°C	82.35	83.12	.....	82.91	.....	.....	13.26	13.13	.....	13.02	.....	.....	0.161	0.158	.....	0.157	.....	.....
solution	95°C	77.09	77.17	76.92	76.83	77.11	76.95	12.10	11.73	11.85	11.60	11.64	11.54	0.157	0.152	0.154	0.151	0.151	0.150
pH=3.0	boiling	76.79	76.91	76.32	76.98	76.03	76.89	11.98	12.07	.....	11.78	.....	11.61	0.156	0.157	.....	0.155	.....	0.150
HCL	60°C	79.28	.....	80.10	.....	.....	75.93	12.84	.....	13.14	.....	.....	11.92	0.162	.....	0.164	.....	.....	0.157
solution	95°C	70.02	69.55	69.72	69.17	69.45	69.27	11.06	10.85	10.88	10.72	.....	10.67	0.158	0.156	0.156	0.155	.....	0.154
pH=2.6	boiling	70.49	69.83	70.13	69.36	69.51	.....	11.35	11.37	11.01	10.82	10.91	.....	0.161	0.160	0.157	0.156	0.157	.....
HCL solution	95°C	77.41	77.46	77.23	.....	77.16	77.29	11.15	11.15	10.89	.....	10.73	10.82	0.144	0.144	0.141	.....	0.139	0.140
pH=1.9	boiling	76.50	.....	76.72	.....	.....	.....	10.94	.....	10.74	.....	.....	.....	0.143	.....	0.140	.....	.....	.....
HCL solution	95°C	81.02	.....	81.05	.....	.....	80.16	10.21	.....	9.97	9.75	9.94	.....	0.126	.....	0.123	.....	.....	.....
pH=1.2	boiling	80.69	.....	.....	80.39	.....	80.07	10.41	10.43	.....	10.01	.....	9.85	0.129	.....	.....	0.124	.....	0.123
HCL solution	95°C	81.91	81.87	82.30	81.97	81.57	.....	8.93	8.60	8.64	8.54	.....	.....	0.109	0.105	0.105	0.104	.....	.....
pH=0.3	boiling	82.26	83.12	82.87	82.19	.....	.....	8.72	8.65	.....	8.14	.....	.....	0.106	0.104	.....	0.099	.....	.....

3.0 have higher degrees of methylation than have those pectins extracted at either higher or lower pH values. By reference to the data in Table I, it is readily seen that this difference in quality of the pectins is entirely masked if the methoxyl percentage of the entire extract (pectins plus impurity) be used as a criterion. Sucharipa*(34)* has emphasized the need of pure materials in working with pectic compounds.

Since, however, the acid extracts containing pectins derived from protopectins contain also the water-soluble pectins present in the plant as free pectins, little information can be gained from the above data as to the state of each of the pectins in the plant. Accordingly in the routine extraction procedure, the acid extractions were used on material which had been practically freed from water-soluble pectins. The uniform extraction procedure chosen was to employ five successive 10-minute extractions, (1) with distilled water and (2) with hydrochloric acid solution (pH of 3.6). Immediately prior to the extraction the weighed sample was extracted with hot alcohol in a Soxhlet apparatus to remove glucosides, resins and terpenes.

THE EFFECT OF MATURITY ON THE PECTIC CONSTITUENTS

In studying the effect of maturity on the pectic compounds, the inner peel (albedo) and the juice sacs (with surrounding locular walls) were dissected out from the fruit; the juice was then pressed from the juice sacs. The albedo and the pressed juice sacs after drying and extracting with hot alcohol were extracted as separate samples by the uniform method adopted above. The pectins of the juice were determined by pouring the juice into chilled alcohol and proceeding according to the uniform method adopted above. The following data were determined for each tissue at each sampling date:

(1) Moisture content of tissue.
(2) Methylated pectin (water soluble) content of tissue.
(3) Protopectin (acid-hydrolyzable) content of tissue.

The fruit was picked from the tree on the sampling dates given and submitted immediately to the laboratory procedure. The sample, taken from adjacent trees at each date, was divided into three equal aliquots; the aliquots were dissected separately and were submitted to exactly parallel procedures. In the case of the grapefruit, each aliquot consisted of three fruit; in the case

TABLE II.—DATA SHOWING THE EFFECT OF MATURITY ON THE PECTINS FROM ALBEDO, PULP, AND JUICE OF VALENCIA ORANGES.

Sampling Date	Tissue	% moisture in tissue	Water Extracted Pectins					Acid Extracted Pectins					Total Extracted Pectins				
			% in tissue	% pectic acid in pectins	% methoxyl in pectins	% methoxyl / % pectic acid	% pectins	% in tissue	% pectic acid in pectins	% methoxyl in pectins	% methoxyl / % pectic acid	% pectins	% in tissue	% pectic acid	% methoxyl	% methoxyl / % pectic acid	% pectins
November 15.	Albedo.	65.3	8.7	92.66	11.58	0.125	97.9	20.6	87.18	11.33	0.130	92.3	29.3	88.80	11.40	0.128	93.9
	Pulp...	80.2	10.2	90.94	9.63	0.106	95.3	19.6	86.51	9.94	0.115	91.0	29.8	88.02	9.83	0.112	92.5
	Juice...	....	....	.....	.....	.....	....	....	.....	.....	.....	....	.01	.....	.....	.....	....
December 21..	Albedo.	66.7	14.3	91.81	11.93	0.130	97.2	15.9	88.24	12.09	0.137	93.7	30.2	89.93	12.01	0.134	95.36
	Pulp...	81.9	14.7	85.83	9.44	0.110	90.1	14.8	83.12	9.47	0.114	87.4	29.5	84.47	9.45	0.112	88.14
	Juice...	....	....	.....	.....	.....	....	....	.....	.....	.....	....	.08	.....	.....	.....	....
January 14...	Albedo.	69.4	17.2	93.18	11.55	0.124	98.4	12.9	85.14	10.98	0.129	91.1	29.7	90.94	11.46	0.126	96.12
	Pulp...	80.1	20.6	91.68	9.99	0.109	96.2	9.8	86.44	9.42	0.109	90.7	30.4	89.99	9.77	0.109	94.40
	Juice...	....	....	.....	.....	.....	....	....	.....	.....	.....	....	.07	.....	.....	0.120	79.0
February 21..	Albedo.	70.5	20.5	99.77	10.92	0.119	96.7	9.6	87.99	11.52	0.131	93.2	30.1	90.56	11.11	0.123	95.58
	Pulp...	83.4	20.3	89.99	9.99	0.111	94.5	9.0	89.38	9.56	0.107	93.7	29.3	89.80	9.85	0.109	94.25
	Juice...	....	....	.....	.....	.....	....	....	.....	.....	.....	....	.11	.....	.....	0.117	82.1
March 16.....	Albedo.	71.9	21.4	92.07	11.14	0.121	97.1	7.7	86.30	11.74	.136	91.6	29.1	90.54	11.29	0.125	95.67
	Pulp...	84.2	18.7	85.26	8.95	0.105	89.3	3.3	84.80	9.50	0.112	89.1	22.0	85.19	9.03	0.106	89.27
	Juice...	....	....	.....	.....	.....	....	....	.....	.....	.....	....	.13	.....	.....	0.110	76.3
April 7.......	Albedo.	72.8	20.8	90.99	10.65	0.117	95.8	9.0	87.24	12.30	0.141	92.8	29.8	89.83	11.15	0.124	94.87
	Pulp...	84.0	15.3	89.50	8.86	0.099	93.5	3.1	84.75	8.72	0.103	88.7	18.4	88.70	8.84	0.099	92.69
	Juice...	....	....	.....	.....	.....	....	....	.....	.....	.....	....	.10	.....	.....	0.103	77.3
May 1.......	Albedo.	72.3	19.4	92.12	10.13	0.110	96.7	6.9	86.24	11.64	0.135	91.5	26.3	90.58	10.53	0.116	95.34
	Pulp...	86.1	14.6	87.58	8.23	0.094	91.3	1.3	86.48	8.48	0.098	90.3	15.9	87.49	8.25	0.094	91.22
	Juice...	....	....	.....	.....	.....	....	....	.....	.....	.....	....	.09	.....	.....	0.104	78.7
May 18......	Albedo.	72.1	15.3	92.29	10.43	0.113	97.0	5.2	85.40	11.96	0.140	90.8	20.5	90.54	10.81	0.120	95.42
	Pulp...	75.0	11.0	91.04	9.20	0.101	95.2	5.7	82.49	8.66	0.105	86.4	16.7	88.12	9.01	0.102	92.19
	Juice...	....	....	.....	.....	.....	....	....	.....	.....	.....	....	.....	.....	.....	0.099	75.3
June 5.......	Albedo.	72.9	13.7	92.35	10.07	0.109	96.9	4.5	85.73	11.67	0.136	91.0	18.2	90.71	10.46	0.116	95.44
	Pulp...	73.1	11.2	85.56	8.05	0.043	90.2	3.6	84.16	9.17	0.109	88.3	14.8	85.94	8.32	0.097	89.70

TABLE III.—DATA SHOWING THE EFFECT OF MATURITY ON THE PECTINS FROM ALBEDO, PULP, AND JUICE OF NAGAMI KUMQUATS.

Sampling Date	Tissue	% moisture in tissue	Water Extracted Pectins					Acid Extracted Pectins					Total Extracted Pectins				
			% in tissue	% pectic acid in pectins	% methoxyl in pectins	% methoxyl / % pectic acid	% pectins	% in tissue	% pectic acid in pectins	% methoxyl in pectins	% methoxyl / % pectic acid	% pectins	% in tissue	% pectic acid	% methoxyl	% methoxyl / % pectic acid	% pectins
September 6..	Albedo.	60.1	8.1	92.94	12.08	0.130	99.4	25.3	85.48	11.53	0.135	90.7	23.4	87.30	11.66	0.133	95.57
	Pulp...	78.3	7.4	89.70	9.96	0.111	94.2	20.8	86.43	10.54	0.122	91.2	28.2	87.30	10.38	0.119	91.99
	Juice..	....	....	.....	.....	.....	....	....	.....	.....	.....	....	0.01	.....	.....	.....	.....
October 12....	Albedo.	68.3	12.2	91.80	11.29	0.123	96.9	19.7	87.10	11.50	0.132	92.3	31.9	88.90	11.41	0.128	94.06
	Pulp...	80.2	12.3	89.94	10.97	0.122	94.9	16.8	85.09	10.21	0.120	89.7	29.1	87.11	10.52	0.121	91.86
	Juice..	....	....	.....	.....	.....	....	....	.....	.....	.....	....	0.06	.....	.....	.....	.....
November 2..	Albedo.	64.7	20.6	92.53	11.66	0.126	97.8	12.2	85.83	11.67	0.136	91.1	32.8	90.03	11.66	0.129	95.30
	Pulp...	79.4	18.7	87.38	9.35	0.107	91.6	9.9	87.31	10.39	0.119	92.0	28.6	87.34	9.70	0.111	91.72
	Juice..	....	....	.....	.....	.....	....	....	.....	.....	.....	....	0.12	.....	.....	0.129	79.3
December 18..	Albedo.	69.1	27.7	91.95	11.40	0.124	97.1	5.3	86.25	12.07	0.140	91.7	33.0	91.03	11.50	0.126	96.23
	Pulp...	81.3	17.3	88.47	10.70	0.121	93.3	8.0	82.71	10.17	0.123	87.3	25.3	86.64	10.53	0.121	91.40
	Juice..	....	....	.....	.....	.....	....	....	.....	.....	.....	....	0.32	.....	.....	0.134	71.2
January 12...	Albedo.	68.7	25.3	91.43	10.79	0.118	96.3	7.2	87.76	12.02	0.137	93.2	32.5	90.61	11.06	0.122	95.61
	Pulp...	83.0	17.7	89.52	11.12	0.123	94.5	3.0	84.39	10.63	0.126	89.2	20.7	88.74	5.67	0.064	91.30
	Juice..	....	....	.....	.....	.....	....	....	.....	.....	.....	....	0.28	.....	.....	0.121	77.5
February 4...	Albedo.	71.2	23.9	92.20	11.06	0.120	97.2	7.2	85.97	10.92	0.127	90.9	31.1	90.77	11.02	0.121	95.75
	Pulp...	82.4	15.8	87.27	7.59	0.987	90.7	2.4	85.54	10.09	0.118	90.1	18.2	87.03	7.91	0.091	90.60
	Juice..	....	....	.....	.....	.....	....	....	.....	.....	.....	....	0.19	.....	.....	0.116	80.7
March 10.....	Albedo.	73.1	20.4	93.58	10.67	0.114	98.4	5.9	85.34	9.64	0.113	89.7	26.3	91.71	10.43	0.114	96.42
	Pulp...	82.7	13.9	88.06	8.89	0.101	92.1	1.7	80.39	8.60	0.107	84.3	15.6	87.17	8.85	0.101	91.17
	Juice..	....	....	.....	.....	.....	....	....	.....	.....	.....	....	0.21	.....	.....	0.112	79.2
April 7.......	Albedo*	84.6	14.3	93.61	9.92	0.106	98.1	0.8	.....	.....	.....	91.0	15.1	.....	.....	.....	.....
	Pulp...	85.1	11.2	83.63	8.11	0.097	87.3	1.8	82.97	9.13	0.110	87.1	13.0	83.46	8.24	0.099	87.18
	Juice..	....	....	.....	.....	.....	....	....	.....	.....	.....	....	0.14	.....	.....	0.083	74.4
May 10......	Albedo†	....	....	.....	.....	.....	....	....	.....	.....	.....	....	.....	.....	.....	.....	.....
	Pulp...	84.3	11.8	88.08	8.02	0.091	91.7	0.9	82.39	8.57	0.104	86.2	12.7	87.63	8.05	0.092	91.27
	Juice..	....	....	.....	.....	.....	....	....	.....	.....	.....	....	0.07	.....	.....	0.067	75.1

*The Albedo at this stage is gelatinous in texture.
†The Albedo at this stage has practically vanished.

of the orange, each aliquot consisted of five fruit, and in the case of the kumquat, of one hundred fruit.

Some typical results for Valencia oranges and Nagami kumquats are shown in Tables II and III.

Tables II and III show that the percentage of total pectic compounds in the albedo and in the pulp remains practically constant throughout a long portion of the growth period and then gradually declines; the period of decline begins in the pulp during the early-ripe stage and in the albedo a little after the full-ripe stage. The tables show also that the percentage of water-soluble pectins in the albedo and in the pulp rises to a maximum value and then declines; in each case the maximum value is reached shortly before the decline in percentage of total pectic compounds. The increase in water-soluble pectic content indicates a concomitant increase in hydrophilic colloids in the outer layers of the cell-walls*(1)*,*(6)*; according to Reed*(32)*, the translocation of water takes place by means of these hydrophilic colloids.

In the orange and grapefruit, this conversion of albedo protopectins into pectins occurs more slowly than in the kumquat so that in the full-ripe orange and grapefruit the albedo retains considerable rigidity if the normal course of maturing has been followed. In the full-ripe kumquat, on the other hand, most of the albedo protopectin has been hydrolyzed, giving the albedo a gelatinous texture; with the advance of senescence the albedo practically disappears.

Tables II and III show also that the sum of the pectic acid content and the methylene equivalent of methoxyl content is close to 97 percent for the albedo extracts, whereas for the juice pectins (and to some extent for the pulp pectins) the data show the presence of 15 percent to 22 percent of impurities other than ash. Moreover the ratio of methoxyl percentage to pectic acid percentage did not remain constant during a series of reprecipitations as shown by the following representative data for some albedo pectins (Table IV).

Wendelmuth*(39)* has demonstrated a decrease in viscosity accompanying repeated precipitations; Sucharipa*(34)* and Myers*(22)* have shown that two pectins with practically the same methoxyl content may have widely different viscosities and jellying-power. These facts have been interpreted by various authors as being caused by decomposition of the pectins during the purification process or by differential solubility of the differently methylated pectins. The fact, however, that in many cases cited in the literature the sum of the pectic acid content and the methylene equivalent of methoxyl content shows evidence of 10 percent to 20 percent impurity would seem to point to the possibility of a methoxyl-bearing impurity. Some support might be adduced for this suggestion by recalling that there have been frequent references in the literature to pectins with methoxyl percentages considerably above 11.76 percent (the methoxyl percentage corresponding to Nanji, Paton and Ling's tetra-methylated pectic acid).

The degree of methylation of the extracted pectins as indicated by the ratio of methoxyl percentage to pectic acid percentage is, according to Tables II and III, at all times lower in the water-soluble pectins than in the acid-extracted pectins. This difference is least just prior to the decline in total pectic content. No such pronounced difference is evident in the methoxyl percentages of the water-soluble and acid-extracted pectins.

The degree of methylation of the water-extracted pectins declines markedly with the progress of maturity in the case of both the albedo and the pulp. In the case of the acid-extracted pectins, the ratio shows no definite trend but ranges about an average value. The water-extracted pectins, reflecting as they do the gradual conversion of protopectin into methylated pectins, should show, according to Fellenberg, Carre and others*(17)*,*(8)*, a progressive demethylation with advancing maturity. On the other hand, the acid-extracted pectins, being derived directly from the source material, should reflect the constant composition of the protopectin. In the case of the kumquat, where the albedo degenerates rapidly, even the acid-extracted pectins show evidence of demethylation.

It is interesting to note that the pectins of lower degree of methylation are usually of greater purity if the sum of the pectic acid content and methylene equivalent of methoxyl content be taken as the criterion. This relation appears to a great extent also in the data of Myers and Baker*(22)*. These facts seem to lend some support to the suggestion advanced above that a methylated impurity may be present: (1) precisely in the cases of less purity is the degree of methylation greatly in excess of the theoretical value calculated on the basis either of Nanji, Paton and Ling's or of Ehrlich's formula and, (2) when one finds the degree of methylation greatest in the most impure preparations one naturally suspects either the impurity of contributing methoxyl, or the pectic acid of having a molecular weight less than that of the more pure pectins. As shown in Table I, however, the use of

TABLE IV.—DATA SHOWING THE EFFECT OF REPRECIPITATION ON DEGREE OF METHYLATION.

Source of Pectin	Stage of Maturity	Extractant	Ratio Percent Methoxyl / Percent Pectic Acid — Precipitation No.								
			1	2	3	4	5	6	7	8	9
Orange Albedo.....	Very Immature	Hydrochloric .. Acid pH=3.6	0.139	0.135	0.131	0.130	0.127	0.125	0.123	0.124	0.123
Orange Albedo.....	Early Ripe.....	Water........	0.120	0.124	.....	0.131	.....	0.123	.....	.....	0.130
Orange Albedo.....	Early Ripe....	Hydrochloric... Acid pH=3.6	0.140	0.133	.....	0.130	.....	0.127	.....	.....	0.125
Orange Albedo.....	Over Mature...	Water.........	0.107	0.110	.....	0.112	.....	0.115	.....	0.114	.....
Kumquat Albedo...	Very Immature	Hydrochloric... Acid pH=3.6..	0.119	.....	0.129	.....	.....	0.130	.....	.....	0.130
Kumquat Albedo...	Over Mature...	Water.........	0.118	.....	0.123	.....	0.127	.....	0.130	.....	0.130
Grapefruit Albedo..	Very Immature	Hydrochloric... Acid pH=3.6..	0.142	0.138	0.135	0.134	0.134	.....	0.133	0.134	.....
Grapefruit Albedo..	Full Ripe......	Water.........	0.121	.....	0.119	.....	.....	.....	0.117	.....	.....

more concentrated acids results in greater pectic acid percentage, smaller methoxyl percentage, and greater purity (according to the criterion adopted above). This would seem to indicate the presence in the extract of a methoxyl-bearing impurity which appears also in the calcium pectate precipitate from which the pectic acid percentage is obtained.

The pectins in the juice are, in general, of low quality and present in small percentages. An exception occurs in the case of the kumquat, where at full maturity the pectin content of the juice sometimes reaches 0.32 percent while the ratio $\frac{\text{percent methyoxl}}{\text{percent pectic acid}}$ reaches 0.134.

Table II shows that the ratio of methoxyl content to pectic acid content reaches in the juice of the orange a maximum value of 0.120 in the pre-ripe stage, falling to a value of 0.097 in the full-ripe stage. Norris*(29)* states that the pectins of orange juice have an average methoxyl content of 8.92 percent. Norris, however, as pointed out by Norman*(26)*, did not calculate his methoxyl content on the basis of the actual pectic acid content; as indicated in a prior discussion, calculations based upon the total sample weight (which includes impurities) frequently give misleading results. Moreover, Norris did not consider the effect of maturity. As shown in Table II, the juice pectins of the orange are at one stage of maturity probably tri-methylated; the table shows also that at an earlier stage they were almost tetra-methylated and at a later stage practically di-methylated.

Tables II and III show that at any stage of maturity, the degree of methylation of the pectins is greatest in the albedo and least in the juice. Fellenberg*(17)* deduced from the methoxyl percentage that albedo pectins were more highly methylated than pulp pectins. No criterion of purity (Ca pectate determination) was available to Fellenberg, however, and calculations based upon methoxyl percentage of total sample are untrustworthy as shown above.

PROPERTIES OF EXTRACTED PECTINS

As the above data show, the amounts of free methylated pectins and of pectins derivable from protopectins present in the tissue vary with maturity; the properties also of these extracted pectins vary with maturity. The following properties of the extracted pectins were studied: 1, viscosity; 2, jelly strength; 3, the ratio

$$\frac{\text{Ca}}{\text{Ca pectate}}$$

The viscosity measurements were made on 0.5 percent solutions at 25°C. by means of an Ostwald viscosity pipette. The jelly strength measurements were made by means of the device described by Tarr*(38)*; the jellies were prepared according to the standard method of Myers and Baker*(22)*. The values of the ratio $\frac{\text{Ca}}{\text{Ca pectate}}$ were determined by analysis for calcium of the calcium pectate precipitate of the Carre and Haynes procedure for the determination of pectic acid.

Table V shows, for the water-soluble pectins, a close correlation between viscosity, jelly-strength and degree of methylation. The data for the acid-extracted pectins indicate a fair correlation among these properties, but by no means so close as in the case of the water-soluble pectins. In Fig. 1 are plotted the data: jelly strength versus the degree of methylation.

As shown in Table I, the acid-extracted pectins contain much more non-pectic material than do the water-extracted pectins. It is not strange, therefore, that these more impure pectins should show greater variation than the comparatively pure water-soluble pectins.

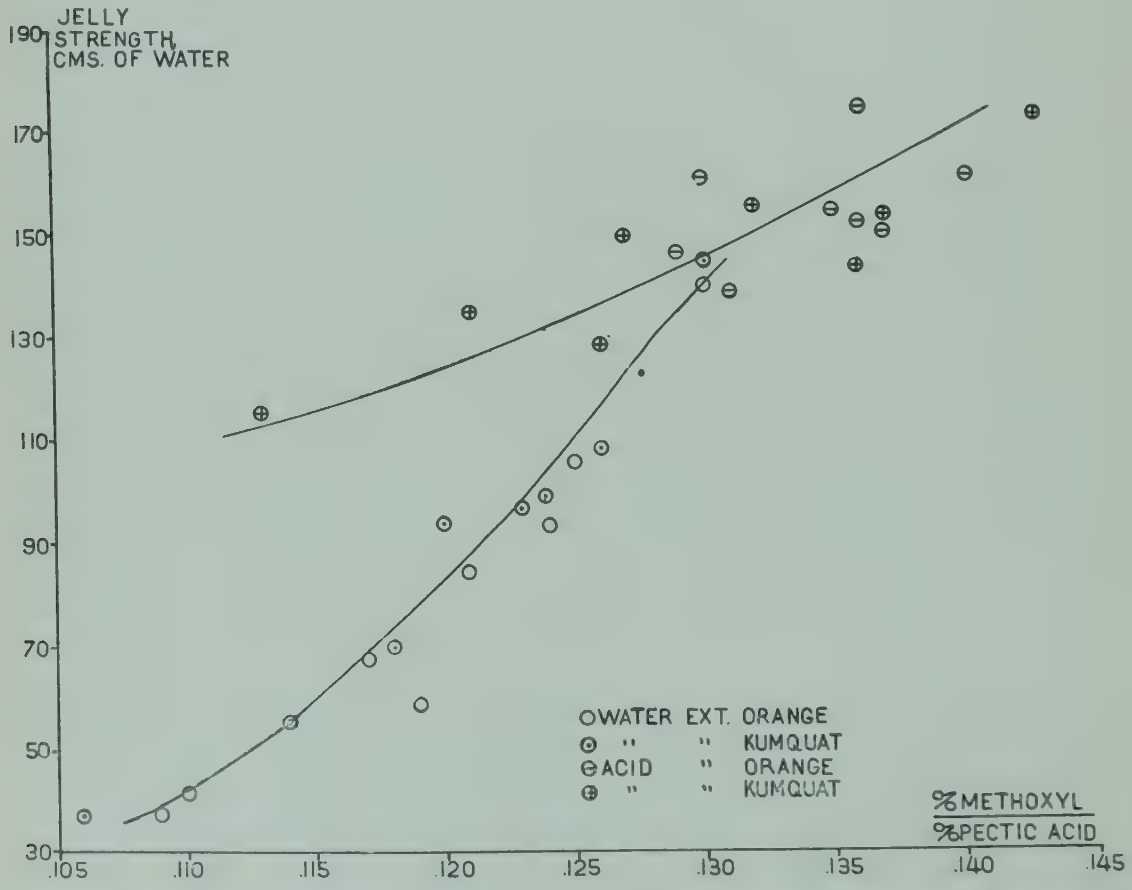

Fig. 1.—Graph showing jelly strength and methoxyl content of pectin of oranges and kumquats.

TABLE V.—DATA SHOWING THE EFFECT OF MATURITY ON ORANGE AND KUMQUAT PECTINS.

Fruit	Date	Ratio $\frac{\%\ \text{methoxyl}}{\%\ \text{pectic acid}}$		Viscosity*		Jelly Strength†	
		Water extracted pectins	Acid extracted pectins	Water extracted pectins	Acid extracted pectins	Water extracted pectins	Acid extracted pectins
Orange......	November 15.	0.125	0.130	14.83	18.82	106	160
	December 21..	0.130	0.137	20.10	21.13	140	150
	January 14...	0.124	0.129	13.42	19.50	94	146
	February 21..	0.119	0.131	11.21	20.44	64	138
	March 16.....	0.121	0.136	19.93	20.27	85	174
	April 7.......	0.117	0.141	9.85	21.01	68	162
	May 1.......	0.110	0.135	6.04	20.73	42	154
	June 5.......	0.109	0.136	5.12	19.41	38	152
Kumquat....	September 6..	0.130	0.135	19.43	18.43	145	134
	October 2	0.123	0.132	13.05	19.51	97	155
	November 2..	0.126	0.136	15.97	20.62	109	143
	December 18..	0.124	0.140	14.02	22.29	99	173
	January 12...	0.118	0.137	10.11	19.12	70	158
	February 4...	0.120	0.127	11.74	19.71	94	149
	March 10.....	0.114	0.113	7.06	16.85	56	115
	April 7.......	0.106	.....	4.27	18.91	37	128

*Relative viscosity.

†In centimeters of water height.

Myers and Baker*(22)*, working with the mixture of water-soluble and acid-extracted pectins, obtained no clear correlation between jelly-strength and degree of methylation of pectins extracted at different pH values. The data in Table V are not necessarily in conflict with Myers and Baker's results, since all the acid-soluble pectins referred to in Table V were extracted at the same pH but from different fruit and at different stages of maturity. Moreover, acid-extraction in the pH range 2.0 to 3.0 results in considerable impurity of the extracted pectin as shown in Table I, and as shown also in Myers and Baker's data; this would introduce some irregularities in subsequent measurements. In fact, as shown in Table I, any correlation existing between jelly strength and the methoxyl content of the pectins would be completely masked if the calculations of methoxyl content were based on the total sample (pectic acid plus impurity).

The data reported in Table V are in agreement with the results of Sucharipa*(35)* and Wendelmuth*(39)* except that these authors employ methoxyl percentage rather than the ratio used above. For water-extracted pectins, because of the greater purity attainable, this difference is probably of no significance. Because of the close agreement between Sucharipa's results and the data of Poore*(31)* obtained with obviously excellent pectins, we must assume that Sucharipa's pectins were of high purity.

Table VI shows the calcium content of calcium pectate obtained from pectins which had been reprecipitated with alcohol (containing no acid). The calcium pectate was in each case prepared precisely according to the procedure of Carre and Haynes*(7)*.

The data show, in the case of the water-soluble albedo pectins, that the calcium content of calcium pectate decreases on repeated purification to approximately the value calculated from the Nanji, Paton and Ling formula for pectic acid and obtained by Carre and Haynes for apple pectin. The initial high results are due probably to the presence of ash; the fall in calcium content seems to be paralleled by a fall in ash content.

In the case of the acid-extracted pectins, considerable impurity other than ash was present; the fall in ash content accompanying repeated purification was not paralleled by a corresponding change in the calcium content of calcium pectate. Moreover, repeated purification caused the pectins to yield lower values for the calcium content of calcium pectate; boiling the purified pectin with hydrochloric acid at a pH of 2.6 caused the pectins to yield higher values. Whether the impurity present originally in the acid-

TABLE VI.—DATA SHOWING EFFECT OF REPRECIPITATION ON CALCIUM CONTENT OF VARIOUS CALCIUM PECTATES.

Source of Pectin	Stage of Maturity	Extractant	Percent Calcium in Calcium Pectate Precipitation No.								
			1	2	3	4	5	6	7	8	9
Orange Albedo	Immature	Water	7.93	7.71	....	7.62	....	7.50	....	7.49	....
Orange Albedo	Immature	Acid	8.76	....	8.06	....	7.91	7.72	7.52	....	7.54
Orange Albedo	Early Ripe	Water	8.03	....	7.67	....	7.52	....	7.42	7.41	....
Orange Albedo	Early Ripe	Acid	8.92	8.31	....	7.73	7.64	7.52	....	7.53	....
Orange Albedo	Overripe	Water	9.01	8.47	....	8.09	7.88	7.76	7.65	7.63	7.60
Kumquat Albedo	Immature	Water	7.76	....	7.66	....	7.54	7.48	7.46	....	....
Kumquat Albedo	Immature	Acid	....	8.31	....	7.68	7.60	....	7.58	7.61	....
Grapefruit Albedo	Immature	Water	7.81	7.70	....	7.63	....	7.51	7.49	7.47	....
Grapefruit Albedo	Immature	Acid	8.17	7.95	....	7.72	....	7.54	....	7.57	....
Grapefruit Albedo	Early Ripe	Water	8.15	....	7.82	....	7.59	7.52	....	7.50	....
Lemon Albedo	?	Water	7.91	7.73	....	7.60	7.54	....	7.50	7.52	....
Lemon Albedo	?	Acid	8.21	....	7.95	7.83	....	7.73	....	7.61	7.59
Orange Pulp	Immature	Water	9.32	....	8.41	8.02	....	7.81	7.65	7.60	7.57
Orange Pulp	Immature	Acid	9.14	....	7.87	....	7.73	7.62	....	7.59	7.62

extracted pectin is a decomposition product of pectic acid is uncertain; the data shown in Tables I and IV would seem to suggest that the contrary is true, since demethoxylation would be presumed to precede other decomposition of pectic acid.

SUMMARY AND DISCUSSION

The foregoing data indicate (1) that in the fruits studied, (orange, grapefruit and kumquat) the percentage of total pectic compounds in the albedo and in the pulp remains constant through a considerable portion of the growth period; (2) that the percentage of water-soluble pectins in these tissues rises to a maximum value just prior to the decline in total pectic content, and then gradually declines; and (3) that the rate of conversion of protopectin into water-soluble pectins is greater in the pulp than in the albedo. Carre*(8)*, Conrad*(9)*, and others have demonstrated the above facts concerning the percentages of pectic materials in whole fruits; the above data seem to indicate that the relations established by the above workers are valid for each tissue separately (at least, for the albedo and the pulp).

Qualitatively it was observed also that the dried pulp tissues were more hygroscopic than the dried albedo tissues. If, as indicated by Reed[3]*(32)*, the hydrophilic colloids of the cell-walls and middle-lamellae serve as avenues for the translocation of water, then the difference in water-absorbing capacity existing at two points would seem to condition the direction and rate of water-translocation between those two points. On this basis, the difference in rates of protopectin conversion referred to above would have a direct bearing on the direction and rate of translocation. The action of gases such as nitrogen and carbon dioxide, which according to Carre and Horne*(8)* accelerate decomposition of pectic compounds, would thus be significant in the disturbance of water-distribution throughout the fruit.

The data presented herewith show also (1) that the degree of methylation is less in the water-extracted pectins than in the corresponding acid-extracted pectins; (2) that the degree of methylation of the water-extracted pectins declines as maturity of the fruit progresses while that of the acid-extracted pectins remains fairly constant; and (3) that the degree of methylation (and also purity) of the pectins extracted from the pulp is less than that of pectins from the albedo and greater than that of pectins from the juice. Moreover, it has been shown that reprecipitation does not produce always a lower degree of methylation as suggested by Wendelmuth*(39)* nor always a higher degree as suggested by Myers and Baker*(22)*. In fact, there were used in this work many pectins (and many also have been reported in the literature) with a degree of methylation considerably above that required by the molecular structure assumed by either Nanji, Paton and Ling, or Ehrlich. This would seem to militate either against the validity of the postulated structures or against the practice of assuming that high methoxyl content indicates absence of pectin decomposition. Some support might be adduced for the latter hypothesis by noting that in most cases those pectins with methoxyl percentages higher than Nanji, Paton and Ling's theoretical value decreased in methoxyl content upon reprecipitation.

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[3] Reed states "the locule walls are cellulose." He probably means, however, "cellulose and pectic compounds."

For the water-extracted pectins, a very close correlation was found between viscosity and degree of methylation and between jelly strength and degree of methylation. For the acid-extracted pectins, only fair correlations were found. There is some disagreement in the literature as to the existence of the above correlations; these differences might disappear if the degree of methylation were considered on the basis of actual pectic acid present.

The percentage of calcium present in the calcium pectates derived from the various reprecipitated pectins approached a value between 7.40 and 7.60. These values are in fair agreement with the value given by Carre for apple pectin; they accord reasonably also with the Nanji, Paton and Ling theoretical value of 7.45.

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AGRICULTURAL EXPERIMENT STATION
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THE ASPARAGUS CATERPILLAR: ITS LIFE HISTORY AND CONTROL

By J. W. Wilson

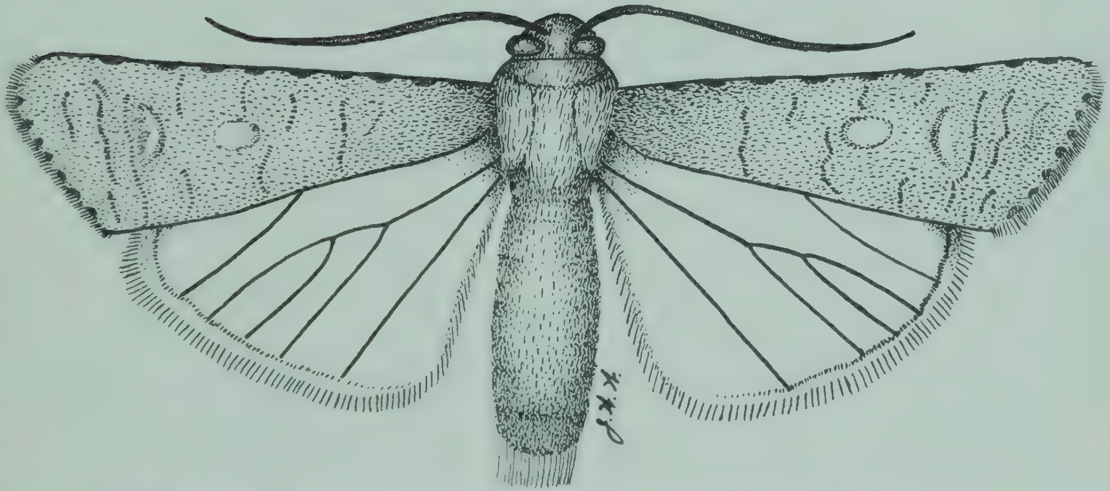

Fig. 1.—Adult asparagus caterpillar, *Laphygma exigua* Hbn.

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THE ASPARAGUS CATERPILLAR: ITS LIFE HISTORY AND CONTROL

By J. W. Wilson

Several species of caterpillars belonging to the cutworm family *(NOCTUIDAE)* occur in the ferneries of Florida and are responsible for more or less injury. Some of these species belong to the semi-tropical army worm group, some to the army worm group, and some to the cutworm group. The asparagus caterpillar, *Laphygma exigua* Hbn., belongs to the same genus as the fall army worm. This species is very abundant in the ferneries north of Auburndale but has not been recorded south of that point. Although this bulletin is concerned only with the asparagus caterpillar, much of the information concerning the life history, natural enemies and control measures are applicable to other species of the semi-tropical army worm group which attack *Asparagus plumosus.*

The asparagus caterpillar is known in the Western States as the sugar beet army worm. In Florida this insect confines itself almost entirely to *Asparagus plumosus* var. *nanus* as a food plant. Thus it is known to the growers of *A. plumosus* as the fern caterpillar and the bud worm. The latter name is applied to the first and second stage larva because of its habit of climbing to the bud and chewing a hole at the base of the tender tip.

HISTORICAL

The first record of the asparagus caterpillar in the United States is the description and notes by Harvey (*5*)[1] in 1876. Harvey collected specimens of this insect in Oregon and California. Larvae were collected in California by Coquillett (Chittenden, *2*) in 1882 and 1886. In 1899 Gillette (*4*) reported the larvae feeding on sugar beets in Colorado. Sanderson (*7*) reported the larvae damaging cotton in Texas in 1904. Marsh (Campbell and Duran, *1*) reported a serious outbreak on sugar beets in Kansas in 1911, and observed a few larvae on turnips at Phoenix, Arizona in 1916. In a letter Dr. Foster H. Benjamin states that this insect is often confused with the fall army worm and probably for this reason escapes detection. According to Dr. Benjamin the asparagus caterpillar is abundant as far east as Brownsville, Texas, and was collected at Quincy, Illinois in 1899, and at Altamonte Springs, Florida in 1924. Mr. J. M. Langstron of the State Plant Board of Mississippi writes that he has specimens in the collection which were taken at A. & M. College and Starkville, Mississippi in August 1920. Larvae of the asparagus caterpillar were also collected feeding on corn at Natchez, Mississippi on May 14, 1931.

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[1] Italic figures in parentheses refer to "Literature Cited" in the back of this bulletin.

Although we have no accurate record of the first appearance of the asparagus caterpillar in ferneries in Florida, it is certain that this insect has been present for a number of years. Specimens sent to the United States National Museum during the summer of 1932 were identified by Dr. Benjamin. At the present time this pest occurs at Pierson, DeLand, Fort McCoy, Leesburg, Yalaha, Groveland, Fern Park, Altamonte Springs and Auburndale. It has not been found south of Auburndale, although ferneries there are infested with species of the related *Prodenia* group which are as destructive as the asparagus caterpillar.

FOOD PLANTS AND NATURE OF DAMAGE

Eighteen plants are listed by Campbell and Duran (*1*) as hosts for the asparagus caterpillar. This list includes sugar beets, table beets, corn, cotton, peas, pepper and a number of wild plants and grasses. DeOng (*3*) reports the larvae feeding on the upper surface of castor bean leaves. The larvae attack the leaves of plants in the blooming stage and feed beneath a protecting web. In Florida this insect is rarely found on plants other than *Asparagus plumosus* though it has been observed feeding on wild grasses and gladiolus. Taylor (*8*) reports that in South Africa tobacco, grapes, young eucalyptus trees, and lawns, as well as cotton, maize and peas are attacked by this insect.

The first and second stage larvae climb to the asparagus bud and chew a hole at its base. Frequently, three or four larvae will be found on the same bud. These holes cause the bud to curl over and so deform the young sprays that they are not salable. The older larvae will feed on all parts of the plant, but prefer the more tender sprays which have just begun to feather out.

It is difficult to estimate the amount of damage inflicted by the asparagus caterpillar because of the fluctuations in the market value of *A. plumosus* during the summer, and because of the variable thoroughness with which control measures are applied. The greatest injury occurs during the rainy season which usually lasts from eight to 12 weeks between mid-June or July and September. During much of this period some rain falls almost every day; frequently the amount is as much as one inch in an hour. These frequent and heavy rains make it difficult to keep the plants covered with an insecticide. Thus the damage multiplies with increased rainfall (see Table 2 for rainfall records). The caterpillars frequently become abundant enough to destroy completely a crop if control measures are not initiated promptly.

LIFE HISTORY AND HABITS

The life history and habits of the asparagus caterpillar in California have been discussed by Campbell and Duran (*1*), and by Chittenden (*2*). Notes on the life history and habits in Florida were published by Wilson (*11*) in 1932.

No migration such as has been described for the fall army worm has been observed for either the adults or larvae of the asparagus caterpillar. Unlike the fall army worm, this species is able to pass the winter in colder climates, and does not have the seasonal migrations characteristic of the fall army worm.

Emergence of the adult moths (Fig. 1) occurs during the night. Mating may take place soon after the adult arrives at the soil surface, as is shown by the fact that fertile eggs have been deposited in the laboratory cages the evening following that of emergence. Practically all of the activities occur at night, although the moths may be observed flying through the fernery in the daytime. The eggs are laid in masses, usually on the underside of the fern spray. These masses are covered over with scales from the female's body. Such egg masses are frequently confused with spider egg masses by growers.

Growers should make an effort to familiarize themselves with the egg masses for they are one of the first indications that an attack by the caterpillar is impending. When large numbers of the egg masses are observed, a heavy infestation of the larvae is to be expected in two or three days. When young plants are scarce, egg masses have been observed on dead and dry stems left in the fernery.

Egg masses collected in the fernery contained from 50 to 150 eggs, while masses deposited in the laboratory cages ranged from 5 to 145 eggs. The largest number of eggs deposited by a single female was 1,321 and the smallest number was 18.

The average number of eggs for 88 females reared during the course of this work was 604.66 per moth. The eggs (Fig. 2) are ordinarily deposited in adjoining rows and may be placed in one or two layers and are usually covered with whitish scales. The masses are irregular in shape.

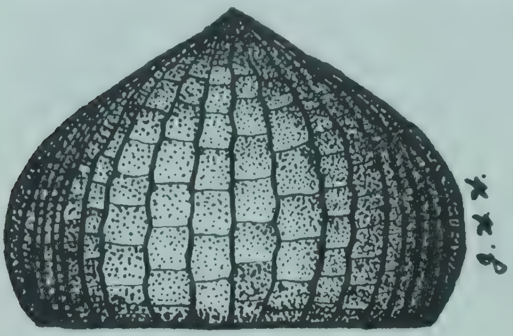

Fig. 2.—Egg of the asparagus caterpillar, greatly enlarged. Original.

The cannibalistic habits of the fall army worm are well known, but, from the author's observations, the asparagus caterpillar (Figs. 3 and 4) does not have this habit to such a high degree. As many as four larvae have been reared without mishap in a two ounce seamless tin box provided with plenty of food. If food becomes scarce, some larvae will devour others.

During the summer months the pupal cell is formed near the surface of the soil—in most cases no deeper than one-fourth inch. Full grown larvae were observed to crawl around over the surface of the soil for a few minutes. When a satisfactory place was located, grains of sand were picked up between the jaws and placed in a curved line around the larva. The sand particles were gradually piled up over the larva and were glued together by a sticky secretion from the mouth. The cells were gradually closed in until only the rear of the larva was left exposed to view. Two larvae completed this part of their cells in 30 minutes. The larvae then crawled into their cells and filled in the opening. The transformed pupa (Fig. 5) was found the following day. The roofs of these cells were of a thickness of only a few grains of sand.

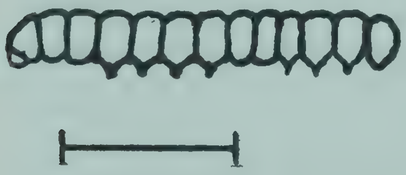

Fig. 3.—Newly hatched larva of the asparagus caterpillar. Original. (Line beneath represents 1/25 inch .x 40.)

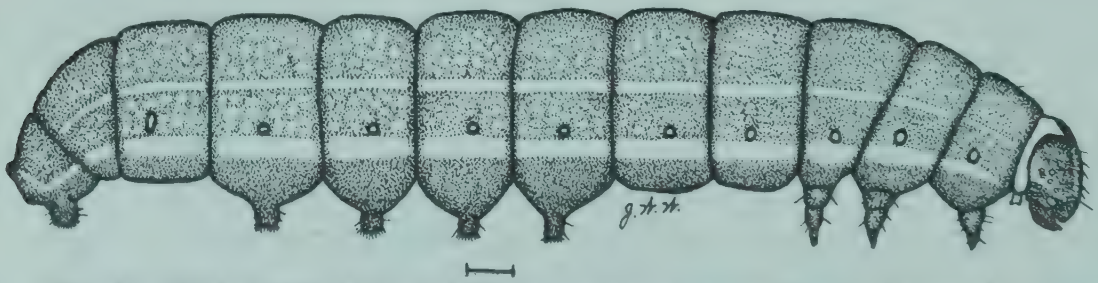

Fig. 4.—Full grown larva of the asparagus caterpillar. Original. (Line beneath represents 1/25 inch.)

SEASONAL HISTORY

The asparagus caterpillar may be found in all stages during every month of the year, but it is not easily found during December, January, February and March because the lower temperatures of these months slow up development and also seem to make the larvae more susceptible to a bacterial disease which greatly decreases the number of larvae present in the ferneries. Although the eggs and larvae may be found in numbers in April, they are usually not abundant enough to cause serious damage until the latter part of May or June. During June, July, August and September when the larvae are very abundant a close watch must be maintained in the ferneries to prevent serious damage. In some years the larvae will be found in large numbers during October.

The asparagus ferneries furnish ideal conditions for the development of the asparagus caterpillar during all seasons of the year. Fresh young foliage is almost always available for the larvae and, since the soil is very rarely cultivated, there is little danger of the pupae being destroyed. The asparagus caterpillar breeds continuously during the winter months though much more slowly than during the summer months.

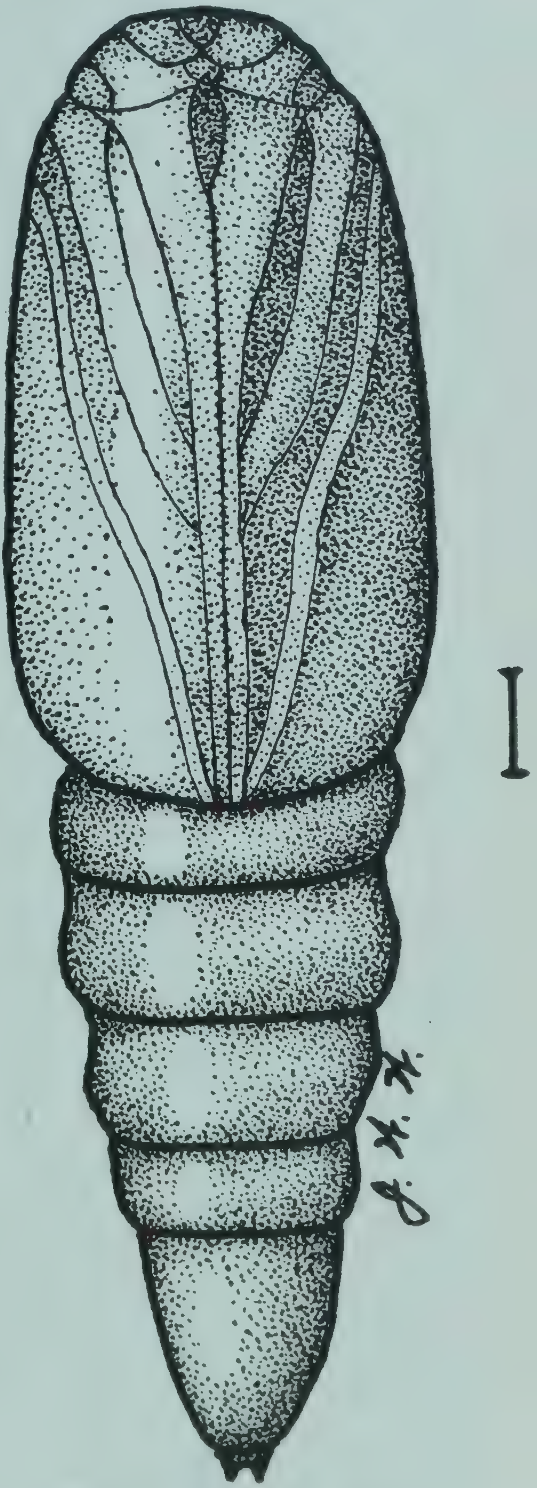

Fig. 5.—Pupa of the asparagus caterpillar. Original. (Line at side represents 1/25 inch.)

DURATION OF ADULT STAGE

After emergence there is usually a period of two or three days before egg laying begins, which is known as the pre-oviposition period. In Table 1 the average duration of the pre-oviposition period is tabulated for each month during

TABLE 1.—DURATION OF STAGES AND TOTAL DURATION OF LIFE FOR ADULT FEMALE AND MALE ASPARAGUS CATERPILLARS OBSERVED AT LEESBURG, FLORIDA DURING 1932 AND 1933.

Month	Number of Females		Ave. Duration Preoviposition Period in Days		Ave. Duration Oviposition Period in Days		Ave. Duration Postoviposition Period		Ave. Duration Female Life in Days		Ave. Duration Male Life	
	1932	1933	1932	1933	1932	1933	1932	1933	1932	1933	1932	1933
April	....	3	....	2.2	....	6.3	....	1.3	....	9.6	....	13.3
May	....	5	....	3.0	....	5.4	....	.6	....	9.0	....	10.2
June	2	8	2.0	2.6	3.0	5.2	0.0	.5	4.0	8.3	2.0*	10.9
July	20	11	3.5	2.8	5.1	4.2	.8	.2	9.4	7.2	9.9	8.3
August	16	3	2.6	2.7	4.9	3.7	.1	1.3	7.6	7.7	8.0	5.3
September	7	....	1.9	....	4.1	....	.2	....	6.2	....	7.0	....

* One individual.

TABLE 2.—AVERAGE MONTHLY MEAN, MEAN MAXIMUM, MEAN MINIMUM, HIGHEST AND LOWEST RECORDED TEMPERATURES, AND RAINFALL AT LEESBURG, FLORIDA FOR THE YEARS 1932 AND 1933.

Month	Mean		Mean Maximum		Mean Minimum		Highest		Lowest		Rainfall	
	1932	1933	1932	1933	1932	1933	1932	1933	1932	1933	1932	1933
January	65.9	63.4	78.3	72.7	58.1	53.9	83	81	42	40	0.81	2.33
February	68.1	66.5	78.9	76.4	61.0	56.9	85	85	45	37	0.34	2.94
March	61.4	65.5	72.6	79.4	51.8	53.5	86	88	34	40	4.97	1.58
April	69.4	69.2	81.1	79.0	58.2	60.5	90	84	50	51	1.42	7.73
May	75.9	79.0	86.6	91.9	66.9	72.8	92	93	57	65	4.21	4.87
June	79.3	78.1	87.5	88.0	74.3	69.1	96	95	69	56	6.16	7.56
July	83.6	80.2	93.5	88.8	75.5	74.4	99	93	71	68	3.37	11.23
August	84.0	80.9	90.1	90.0	78.5	71.9	95	94	73	71	5.96	5.45
September	78.8	80.9	86.8	86.3	72.6	73.2	92	93	65	69	1.26	8.57
October	71.2	74.1	83.3	83.4	66.1	67.1	89	89	54	60	2.95	1.54
November	62.8	61.5	71.9	72.2	54.8	51.9	85	83	40	37	4.50	2.05
December	67.1	61.8	73.5	73.7	55.4	53.0	82	81	35	38	0.12	.64

which observations were made. For comparisons of the duration of the various stages in the adult life with temperature records, see Table 2. During the summer months there is little variation in the length of these stages; but during the colder months there is considerable variation, as is brought out by comparing Tables 1 and 2.

The oviposition period ranges from 3 to 7 days and averages about 5 days for the warmer months. After egg laying is completed, the female moths soon die, living less than a day after completing the oviposition period. The female moth lives from 4 to 10 days and egg laying is usually heaviest during the first three days of the oviposition period. As many as 627 eggs have been obtained on the first day. The largest total number of eggs laid by a single female was 1,321. Several individuals laid from 900 to 1,100 eggs, while the average number of eggs per female as shown in Table 3 is considerably lower. The adult male moth usually outlives the female by several days.

TABLE 3.—AVERAGE NUMBER OF EGGS AND EGG MASSES PER FEMALE *Laphygma exigua* HBN. AT LEESBURG, FLORIDA DURING 1932 AND 1933.

Month	Number of Females		Average Number Eggs Per Female		Average Number Egg Masses Per Female	
	1932	1933	1932	1933	1932	1933
April	....	3	....	876.6	....	15.0
May	....	5	....	590.2	....	12.0
June	2	8	476.0	666.2	9.3	11.7
July	20	11	429.4	762.8	12.2	19.0
August	16	3	543.2	339.7	12.0	12.0
September	7	....	599.7	....	....	....

DURATION OF EGG STAGE

The duration of the egg stage (Fig. 2) is very markedly influenced by the temperature. During the summer months the eggs will hatch in 2 to 3 days, but a variable length of time is required for hatching during the winter months. The longest time recorded for the incubation period was four days during the latter part of October.

Numerous experiments were conducted to determine the duration of the egg stage. This information is tabulated by months in Table 4. The eggs were kept, in all cases, in test tubes plugged with cotton in an open insectary. In no case did the eggs require moisture additional to that of the atmosphere. The Florida climate supplies sufficient moisture for the development of all stages of the asparagus caterpillar in the insectary and fernery. Since all of the eggs kept in the test tubes plugged with cotton hatched, it may be concluded that there is little or no mortality of the unparasitized eggs. A few unmated females deposited a small number of eggs during the latter part of their lives but none of these eggs hatched.

TABLE 4.—DURATION OF THE EGG STAGE OF THE ASPARAGUS CATERPILLAR, OBSERVED AT LEESBURG, FLORIDA DURING 1932 AND 1933.

Month	Number of Egg Masses Used		Average Duration of Egg Stage in Days	
	1932	1933	1932	1933
May	....	105	....	2.5
June	55	82	1.6	2.5
July	176	170	2.1	2.5
August	197	35	2.2	2.0
September	50	1	2.6	2.0
October	14	167	4.0	3.4
November	....	27	....	*

* Eggs failed to hatch on account of cold weather.

It will be noted from Table 4 that 27 egg masses or 716 eggs failed to hatch. These eggs were laid between November 3 and 15, 1933. During the 13-day period Nov. 3 to 15 inclusive the average temperature was 66.7° F. and on 10 of these days the minimum temperature was below 50° F. with 43° F. as a minimum for three of these days. Apparently these temperatures are low enough to prevent hatching. However, eggs laid later in a fernery near the laboratory hatched, for larvae were observed in this fernery during the first part of December.

LARVAL STAGES

The newly hatched larva (Fig. 3) is only 1/25 inch long with a comparatively large black head and light green body covered with small tufts of spines. Hatching is accomplished by chewing a hole in the top of the egg shell through which the caterpillar emerges. After emerging the larva finishes eating the egg shell. All of the eggs in a mass hatch at approximately the same time, and the larvae remain together for a few hours feeding on the near-by foliage, and then they begin to scatter to different parts of the plant.

TABLE 5.—DURATION OF LARVAL STAGE OF THE ASPARAGUS CATERPILLAR OBSERVED AT LEESBURG, FLORIDA DURING 1932 AND 1933.

Month	Number of Larvae Used		Hatching Dates		Pupation Dates		Average Duration Larval Instars, Days	
	1932	1933	1932	1933	1932	1933	1932	1933
May	....	14	....	4-20	....	5/17-6/5	....	15.0
June	8	17	14	15-20	24–28	6/27-7/1	11.5	11.7
July	12	8	1–14	9	14–31	21-24	12.5	13.2
August	1	8	10	2-30	22	8/19-9/14	12.0	12.0
September	....	7	....	26	....	10/5-7	....	9.7
October	....	3	....	21	....	11/3-4	....	13.3
November	....	7	....	2	....	12/7-12	....	37.6

There are five instars or stages through which the larvae pass. Each molt is preceded by a pre-molting period, the length of which depends upon the temperature. During the summer months each stage requires about 2 days which includes 6 to 10 hours for the pre-molting period. The exact length of this pre-molting period was not determined. Only the total length of the larval stage is given in Table 5. Records included in Table 5 are for those larvae only which completed the larval stage, although many more larvae were reared to the third or fourth stage.

During June, July, August and September when the mean temperature ranged from 78.1° F. to 80.9° F. the larval stage was completed in some instances in 10 days, although the average ranges between 11.5 and 13.2 days for these months. During September, 1933 three individuals completed the larval stage in 9 days. During November with an average temperature of 61.5° F. the larval stage required 37.6 days. The cool weather of November prevented the hatching of eggs and most of the pupae died so that a generation of larvae was not reared during December. A single adult male emerged November 27 and died December 12.

TABLE 6.—DURATION OF THE PUPAL STAGE OF THE ASPARAGUS CATERPILLAR AS OBSERVED AT LEESBURG, FLORIDA DURING THE YEARS 1932 AND 1933.

Month	Pupation Dates		Dates of Adult Emergence		Average Duration of Pupal Stage in Days		Number of Males and Females				Ratio of Males to Females
							♂	♀	♂	♀	
	1932	1933	1932	1933	1932	1933	1932		1933		
May	....	5/17-20	....	5/23-27	....	7.0	....	....	3	4	1-1.3
June	6/26-7/1	6/3-6/30	7/1-7/2	6/11-7/8	6.0	6.9	2	5	11	10	1-1.1
July	7/12-7/31	7/1-23	7/19-8/7	7/8-30	6.3	7.2	3	7	6	6	1-1.4
August	8/2	8/19-27	8/9	8/26-9/2	7.0	7.4	0	1	3	4	1-1.6
September	....	9/14	....	9/20	....	6.0	....	....	0	1	1-0.3
October	10/10-11	10/5-7	10/19	10/16-18	8.7	11.0	4	2	6	1	....
November	....	11/3	....	11/27	....	24.0	....	....	1	0	....
Total	....	....	....	....	....	....	9	15	30	26	1-1.05

The full grown caterpillar (Fig. 4) measures one and one-half inches in length and varies in color from a light green to black. The light green individuals show no distinct stripes nor do the black individuals. Some individuals have three distinct light colored stripes running the full length of the body, one at the middle of the back and one at each side. The caterpillars vary so in color that some growers contend that they are separate species. Light green and black individuals have been reared from the same egg mass, though the dark caterpillars are more numerous in the early spring, late fall and winter and the green caterpillars are more numerous during the summer months. This indicates that there is a close correlation between low temperature and dark pigmentation and between high temperature and light pigmentation.

The full grown larvae dig into the soil, form a cell about themselves and transform to the pupal stage. All of the pupae observed in the insectary were in a perpendicular position with the head up.

PUPAL STAGE

Of the individuals completing the pupal stage (Fig. 5) there were slightly more females than males. Luginbill (*6*) reports that female pupae of the fall army worm completed the pupal stage in a slightly shorter time than the male pupae. For the asparagus caterpillar both sexes completed the pupal stage in the same average time. Table 6 gives the duration of the pupal stage for each month during which observations were made.

The length of the pupal stage, like the earlier stages of the asparagus caterpillar, is greatly influenced by the prevailing temperature. When the average temperature is between 78 and 81° F. the pupal stage is completed in from 6 to 8 days, averaging about 7 days. At lower average temperatures the length of the pupal stage is greatly increased (see Table 6).

NUMBER OF GENERATIONS AND LENGTH OF LIFE CYCLE

For the summer months the adult pre-oviposition period averages 2.6 days, the egg stage 2.2 days, the larval stage 12.5 days, and the pupal stage 6.7 days, the sum of which totals 24 days for the length of the life cycle. From June 14 to October 10, 1932 six complete generations were reared. From May 1 to September 20, 1933 six complete generations were reared.

The larvae begin to appear in numbers during April or May and become very abundant during June. After June 1 no distinct generations can be distinguished in the fernery. Sometimes all stages of the asparagus caterpillar will be found in the fernery at the same time. Thus, there are many more than six broods of the larvae to be combatted during a season.

For this reason no definite time can be specified for applying control measures. The need for control measures will vary from fernery to fernery, wherefore each grower must maintain a constant vigilance to determine the proper time for applying insecticides. The proper time is as soon as possible after the eggs hatch. Some growers contend that the very young caterpillars are not large enough to eat sufficient foliage to get a lethal dose of poison and advocate waiting for three days after hatching. Those growers who practice waiting for three days usually suffer a heavy loss. With favorable weather conditions almost complete control of the larvae within eight hours after applying the insecticide has been obtained. The insecticide was, of course, applied to the asparagus foliage when the asparagus caterpillars were only a few hours old.

As an aid to determining the proper time, watch the whitish egg masses on the under side of the young foliage. Mark these egg masses and note the time of hatching. If weather conditions are not favorable for applying the insecticide make an application as soon as weather conditions permit. If this is neglected there is sure to be trouble later.

NATURAL ENEMIES

During the summer months of 1932 conditions for the development of the natural enemies of the asparagus caterpillar were exceptionally favorable. During these months eight parasites, four secondary parasites (parasites preying upon the first parasite and therefore detrimental to the interest of the grower) and two predators were reared from material collected in the ferneries. In 1933 conditions in the same ferneries were not favorable, only a few individuals of two parasites being collected.

Of the eight parasites *Chelonus texanus* Cress. was the most abundant and effective in destroying the larvae of the asparagus caterpillar. No common names for these parasites are known to the author, so scientific names must be used. Next in importance were *Meteorus autographae* Mues. and *Apanteles marginiventris* (Cress.), these two being found in equal abundance. *Euplectrus platyhypenae* How. was observed on several occasions in the ferneries at Leesburg and Pierson, but it was never abundant. At Boynton, however, this parasite was encouraged and it became very abundant, parasitizing the semitropical army worm (*Prodenia sunia* Gn.). Single specimens of *Hyposoter interjectus* Gahan, *Zele melleus* (Cress.), *Gonia crassicornis* Reinh., and *Eucelatoria rubentis* Coq. were reared. The four secondary parasites reared were *Spilochalsis hirtifemora* (Ash.), *Spilochalsis albifrons* Walsh, *Catolaccus aeneoviridis* (Gir.), and *Mesochorus* sp. Two predators very abundant in the ferneries were active in destroying the asparagus caterpillar. These were *Podisus maculiventris* Say and *Polistes fuscatus* var. *rubiginosus* Lep.

Chelonus texanus adults lay their eggs in the eggs of the asparagus caterpillar, and the full grown parasite larva emerges from the third or fourth stage host larva. The other parasites attack various stages of the asparagus caterpillar. One of the principal reasons for the parasites never becoming abundant is that control measures are directed at host larvae, thus destroying the immature parasites with the host asparagus caterpillar.

In addition to the insect parasites of the asparagus caterpillar there is a fungus disease *Spicaria prasina* (Maubl.) Saw. which destroys large numbers of the asparagus caterpillar and a bacterial disease is very destructive during the months of September, October and November.

The vertebrate parasites of the asparagus caterpillar have not been studied although a lizard *Cnemidophorus sexlineatis* (Linn.), "the race runner", is very abundant in the ferneries and a toad, *Bufo quercicus* Holb., also is abundant. These undoubtedly destroy large numbers of the larvae.

HYMENOPTEROUS PARASITES AND SECONDARY PARASITES

ICHNEUMONIDAE

Hyposoter interjectus Gahan.: Vickery (*10*) does not list this insect as a parasite of the fall army worm in Texas nor does Luginbill (*6*) give it as a parasite of this insect in the Southeast. Only one specimen was reared at Leesburg, thus it may be only an occasional parasite of the *Laphygma*. The pupa was collected in the insectary from a cage containing a large number of asparagus caterpillars on June 5, 1932. The adult emerged on June 10, 1932.

Mesochorus sp.: Three pupal cases of this secondary parasite of the asparagus caterpillar were collected in the fernery on August 15, 1932 and the adults emerged August 22, 1932. This secondary parasite is given by Luginbill as a parasite of *Meteorus laphygmae.* Luginbill also states that three individuals were reared from 295 *Meteorus laphygmae* cocoons, indicating that this is an insignificant secondary parasite.

BRACHONIDAE

Chelonus texanus Cress.: Numerous attempts were made to rear this parasite in captivity. Vickery (*10*) has found that it is necessary to have the host larva go into the ground prematurely and construct a cell known as the death cell. Under the conditions prevailing in the insectary the writer was unable to get the host larva to construct the necessary death cell. Numbers of the *Chelonus* larvae emerged from the host but because of the absence of the cell they soon died. As has already been indicated, this insect was very abundant in the fernery and frequently emerged from host larvae collected in the fernery. Vickery states that 33 percent of all the fall army worms collected at Brownsville, Texas were parasitized by this insect. Since large numbers of the host were collected this probably represents the actual status of this parasite in the vicinity of Brownsville.

The adult female oviposits directly in the eggs of the asparagus caterpillar. Females were placed in test tubes containing eggs of the asparagus caterpillar and they usually began ovipositing immediately. The female parasite approaches the egg mass and places the antennae on an egg, she then places the ovipositor over an egg retaining it there for a few seconds. The female will work back and forth over the egg mass selecting eggs at random, the antennae vibrating vigorously all of the time.

The host egg develops normally, hatching in the same length of time as unparasitized eggs. The host larva also develops normally to the third or fourth instar. Parasite larvae reared in the insectary at Leesburg emerged from the host during the third instar. The host larva attempted to pupate 11 to 14 days after the parasite egg was laid. The Chelonus larva emerged from the caterpillar on the 12th to the 15th day after oviposition by the female. Vickery gives the time elapsing from oviposition to the time of cocoon formation as 11 days in August and 22 days in October. At Columbia, South Carolina the time elapsing between the hatching of the fall army worm larva to pupation of the Chelonus was 12 to 14 days.

Luginbill (*6*) states that the parasite passes the winter as a pupa in the cocoon. Adult *Chelonus* feed at the nectaries of cotton and a number of other plants. Data on the number of generations produced during a season were not obtained.

Apanteles marginiventris (Cress.) is another parasite abundant in the ferneries at Leesburg. The female Apanteles lays her eggs in the first instar larvae of the host usually before they disperse. Oviposition is accomplished very quickly, the female thrusting her ovipositor into the larva and withdrawing it immediately.

According to Vickery the length of time from oviposition to the emergence of the full grown parasite larva varies considerably even in groups of parasite eggs laid at the same time. In June the time ranged from seven to 11 days; in October from seven to 13 days, and in November from 10 to 14 days. A single parasite larva emerges from each parasitized asparagus caterpillar during the fourth instar. Adults emerged from cocoons collected in the fernery after 2 to 6 days, the average being 3.3 days. The shortest pupal state for this parasite in Texas was five days.

Meteorus autographae Mues.: This parasite was found in the ferneries in about the same numbers as *Apanteles marginiventris*. Observations on the oviposition and length of the larval stage have not been made. Numbers of adults, however, were reared from parasitized larvae brought into the insectary. The adult parasite emerged from cocoons formed in the insectary after six days. The adult female usually lays her eggs in second or third instar host larvae. This parasite may reproduce without mating but the progeny are always males when the female is not fertilized.

Zele melleus (Cress.): A single specimen of this parasite was reared from a parasitized larva of the asparagus caterpillar by C. C. Goff at Leesburg in June, 1931. Various entomologists of the U. S. Bureau of Entomology have reared this parasite in small numbers from the fall army worm. Vickery reared only three adult *Zele melleus* from 16,000 fall army worm larvae at Brownsville, Texas.

CHALCIDIDAE

Two secondary parasites belonging to this family were reared, both from *Apanteles marginiventris* (Cress.).

Spilochalcis hirtifemora (Ashm.): Two individuals of this secondary parasite were reared from cocoons of *Apanteles marginiventris* collected in the fernery. The adults emerged 10 days after the cocoons were collected.

Spilochalcis albifrons Walsh: A single specimen of this species was reared from cocoons of *Apanteles marginiventris* collected in the fernery. The adult *S. albifrons* emerged seven days after the cocoons were collected. The adults of this and the preceding species were reared during August.

PTEROMALIDAE

Catolaccus aeneoviridis (Gir.): Several adults of this small black secondary parasite were reared from cocoons of *Apanteles marginiventris* collected in the fernery during July and August. One adult *C. aeneoviridis* emerged 2 days, one 3 days, one six days and several 10 days after the cocoons of *A. marginiventris* were collected in the fernery.

All of the secondary parasites were reared in such small numbers that they appeared not to reduce the primary parasites to an appreciable extent.

EULOPHIDAE

Euplectrus platyhypenae How.: Although this parasite was not collected in large numbers at Leesburg it is easily reared, and being a gregarious external parasite all stages of the life cycle can be observed with little difficulty. Probably the systematic application of arsenate of lead reduces the numbers of this parasite, as the female prefers to oviposit on the third or fourth stage host larvae. This parasite has been reported as parasitizing a number of noctuid species. The list includes 13 species of Noctuidae. At Leesburg it was reared from the asparagus caterpillar and was observed on *Prodenia sunia* Gn. at Boynton, Florida.

At one time during the life history studies, first and second stage host larvae were all that were available for the female parasites to oviposit on. For 10 days these small larvae were offered to the parasites but no eggs were deposited until third and fourth stage host larvae were made available. The eggs are laid in groups ranging from three to 30 in number usually on the thoracic or first three abdominal segments. Eggs placed on the posterior abdominal segments are frequently knocked off by the host larva after the eggs hatch.

During the months of June to September, 1932, inclusive, with an average temperature of 81.4° F. the average length of the egg stage was 2.28 days. During this time 9 generations were reared. From the middle of November to the latter part of December while the average temperature was 63.2° F. the egg stage lasted 8 days. The average length of the larval stage for the first 9 generations was 3.53 days. The 12th generation larvae (reared during December) required 9.75 days for development.

Parasitized asparagus caterpillars did not molt after the parasite eggs were laid. Frequently the female parasites refused to lay eggs on larvae almost ready to molt, but waited until the skin had been shed. The host larvae feed normally throughout the period of the parasite larval development. When the parasite larvae become full grown they move around to the ventral surface of the host and tie it down with silk threads. A few threads of silk are spun about the parasite and the pupa is formed beneath the dead host larva. In Florida the parasites continue development during the winter although the life processes are slowed down during cool periods.

VESPIDAE

Polistes fuscatus var. *rubiginosus* Lep.: Large numbers of these wasps were present in the ferneries during the entire summer of 1932. C. C. Goff observed the wasp capturing the larva and preparing it for transportation back to the nest. Mr. Goff's description of the process follows: "After following a wasp about for some time I saw her make a dart for a large larva but for some reason she missed her prey. Several times larvae escaped by falling to the ground as the wasp approached. Finally the wasp was successful in capturing a larva probably in the fifth instar. As far as I was able to observe the wasp did not sting the larva but immediately began to chew at it vigorously, holding the larva with her front feet. In approximately five minutes the wasp had peeled the skin from the larva and then flew away with the viscera."

HEMIPTERA

PENTATOMIDAE

Podisus maculiventris Say: This predacious bug was very abundant in the ferneries at Leesburg from the latter part of June to the latter part of August, 1932. The adult has a long life and is a voracious feeder, one adult captured on June 26 lived to September 4, during which time 122 asparagus caterpillars were consumed. The stink bug approaches the larva cautiously with the beak outstretched, and immediately presses the beak into the larval skin. By the time the larva begins to wiggle in an attempt to escape, the stink bug has secured sufficient hold to make any amount of wiggling unsuccessful. No larvae were observed to escape.

The eggs are placed in masses on the asparagus sprays or other convenient supports. A female captured in the fernery on August 5 had laid a total of 871 eggs by September 23. Two reared females laid 238 and 768 eggs, respectively. The average length of the egg stage during September 1932 was 5.08 days with an average temperature of 78.8° F. during the same time.

The newly hatched nymph has a black head and thorax and red abdomen with black marginal spots on each segment and four transverse black spots at the center of the dorsal surface. The nymphs from an egg mass stay together for the first two or three days, moving about in a body in close formation. Although very young nymphs feed on the tender plant shoots they do not appear to injure the asparagus plants, and after their first few meals they begin feeding on the smaller larvae. The nymphs molt five times and require 20 to 23 days during the latter part of August and the first part of September to complete their development.

Three generations of this predator were reared from August to December 20 when the supply of asparagus caterpillars gave out. This species probably passes the winter in the adult stage. In addition to the asparagus caterpillar it feeds upon a number of other insect larvae.

DIPTERA

TACHINIDAE

Gonia crassicornis Reinh.: A single specimen of this dipterous parasite was taken from a rearing cage on July 1, 1932. Van Dine (*9*) also reared this parasitic fly from a fall army worm larva in Porto Rico in 1912. It appears to be a rare parasite of the asparagus caterpillar.

Eucelatoria rubentis Coq.: A single specimen was reared by C. C. Goff in 1931. The larval parasite emerged from the host larva on August 27 and the adult fly emerged on September 4, 1931. This also appears to be a rare parasite as it is mentioned by neither Luginbill nor Vickery.

FUNGI

The fungus *Spicaria prasina* (Maubl.) Saw. during wet weather destroys enormous numbers of asparagus caterpillars, attacking the larvae in all stages. This fungus has been observed to destroy entire infestations of the caterpillar when the optimum weather conditions prevailed for its development. The infected larva becomes stiff and is covered with a white mass of mycelia soon after death. These mycelia bear green spores which after a short time give the dead larva a green appearance.

BACTERIA

A bacterium, not yet identified, was found destroying many of the larvae in rearing cages in the insectary. Only a few caterpillars that appeared to have been killed by this bacterium have been found in ferneries. Some caterpillars were destroyed during all of the summer months. However, it became very difficult to rear larvae to maturity during September and October on account of attacks of this bacterium. There seems to be some relationship between the lower temperatures of these months and increased mortality of the larvae. Whether this phenomenon is due to the fact that these lower temperatures are more favorable to the development of the bacterium or that the resistance of the caterpillars is decreased by the lower temperatures has not been determined.

CONTROL MEASURES

The practice of planting *Asparagus plumosus* plants about six by 10 inches apart and the low, compact growth of the plants makes dusting the most desirable and economical means of controlling the asparagus caterpillar. Many fern growers plant *Asparagus plumosus* in beds three feet wide, leaving 12 inch paths between, while others plant the entire fernery, leaving no paths. Under these conditions the handling of spray hose in such a way as to prevent injury to the plants is quite an item in the cost of applying a spray. The dust, if properly applied, will give a better coverage of the plants and can be put on in approximately one-eighth the time of that required for spraying.

However, liquid sprays containing pyrethrum and rotenone compounds in varying proportions were tested. The degree of control obtained with these materials was not satisfactory.

The fluosilicate compounds used in similar tests were also unsatisfactory, all giving a poor control when compared with arsenate of lead. The dusts containing sodium and barium fluosilicate severely injured the plants.

In Table 7 the yield per acre of marketable sprays is calculated from the results of a typical series of plot tests. This table shows clearly that undiluted arsenate of lead was the most effective of these materials. No injury to the plants could be attributed to the use of this dust.

TABLE 7.—COMPARATIVE EFFECTS OF DIFFERENT INSECTICIDES UPON THE CONTROL OF THE ASPARAGUS CATERPILLAR AS DETERMINED BY THE YIELD OF MARKETABLE SPRAYS PER ACRE.

Material Used	Number Marketable Sprays
Untreated check	13,452
Arsenate of lead undiluted	40,890
Rotenone (5% on label)	20,392
Arsenate of lead 50%, lime 50%	28,826
Calcium arsenate 50%, lime 50%	28,719
Calcium arsenate undiluted	25,516
Synthetic Cryolite 10%, Kaolin 90%	13,345
Pyrethrum "A" dust	24,876
Magnesium arsenate 20%, Kaolin 80%	24,449

Growers have been using arsenate of lead as a control measure for a number of years. Still some of them complain that they do not get control. According to the author's observations the reasons for failure to obtain control are as follows:

1. Failure to dust at the proper time.
    - A. Ignorance of the life history and habits of the asparagus caterpillar.
    - B. Excuses of being too busy with other things.
    - C. Failure to keep up with what is going on in their ferneries.
2. Failure to apply the dust properly.
    - A. Relying upon cheap labor.
    - B. Insufficient attention to labor.
3. Weather conditions.

As has been explained on previous pages the growers must familiarize themselves with the life history and habits of the asparagus caterpillar in order to apply control measures intelligently. When the egg masses are observed in numbers there are sure to be larvae in about two days. The dust should be applied immediately on the appearance of the larvae. It is best to apply it as early as possible in the morning. At this time of the day weather conditions are most favorable. There is usually some dew on the plants, little or no wind, and one may usually count on a period of about 8 hours before a rain. If the dust is applied to the newly hatched larvae, control can be obtained in approximately 8 hours.

If an excellent crop of asparagus ferns is to be grown, enough labor should be available to take care of all phases of production including culture and harvesting. Sometimes growers become engrossed in harvesting and fail to think, in time, of the crop to come.

Although some growers know about the life cycle of the asparagus caterpillar and have sufficient labor available, they sometimes for one reason or another fail to recognize the need for dusting until after considerable damage has been done.

Most of the dusting in the Leesburg area is done by hired labor with a Savage type duster. If the laborer takes short steps, turns the duster handle at the proper speed, and swings the nozzle of the duster over a wide enough area an excellent coverage with the dust can be obtained. Many laborers walk too rapidly when dusting and a crooked trail of the duster can be followed through the fernery.

Another point is the height of the duster nozzle above the tops of the plants. The duster nozzle should be held so that the dust cloud is placed from six to 12 inches above the tops of the plants. If this is done a uniform coat of dust will settle on all parts of the plants.

While the dust is being applied a responsible person should constantly watch the application of the dust as the labor used in ferneries usually cannot be relied upon to do as instructed unless constantly reminded to do so.

It sometimes happens during the summer that for three or four days there will be some rainfall during all hours of the day. Under such circumstances it will be impossible to obtain control. It is advisable to watch the weather forecasts and see to it that there are no larvae present in the fernery at the commencement of a rainy period.

Although there has been some objection to the use of arsenate of lead in large quantities year after year, on the grounds that so much arsenate of lead in the soil is injurious to the plants, this is the only material available at the present time which can be relied upon to give control of the asparagus caterpillar. If the proper precautions are taken and arsenate of lead is applied at the right time little damage will be inflicted by the asparagus caterpillar.

SUMMARY

The asparagus caterpillar is the most abundant of the night flying moths found in the ferneries in Florida. This insect has been reported to feed on 18 plants other than asparagus plumosus, but in Florida it has rarely been found outside of ferneries. There is no definite record of its first appearance in the ferneries but it has been in the state for a number of years.

The damage inflicted is of two types: (1) the young larvae feeding on the tender buds, and (2) the older larvae feeding on the more advanced growth.

Eggs are laid on the underside of the sprays in masses. These masses are usually covered with scales from the female moth's body. The eggs hatch in two to three days during the summer. The larvae molt five times and require nine to 15 days (during the summer months) to complete this stage. The mature larvae form a pupal cell a short distance below the soil surface and remain in this cell for six to 11 days during the months from May to October. The length of these stages is increased considerably during the winter months.

A number of primary and secondary insect parasites of the asparagus caterpillar have been collected and reared. Two of these, *Chelonus texanus* Cress. and *Euplectrus platyhypenae* How., are of considerable aid in controlling this pest. The fungus, *Spicaria prasina* (Maubl.) Saw., is instrumental in destroying large numbers of the larvae. An unidentified bacterium also is considered of some slight control value.

The best artificial control which has been developed for the asparagus caterpillar is a timely dusting of undiluted arsenate of lead.

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UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
GAINESVILLE, FLORIDA
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FARMERS' COOPERATIVE ASSOCIATIONS IN FLORIDA

III. Business Analysis of the Hastings Potato Growers' Association

By H. G. HAMILTON and MARVIN A. BROOKER

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HASTINGS POTATO GROWERS ASS'N
SUPERIOR
NEW POTATOES

Fig. 1.—Office building of the Hastings Potato Growers' Association.

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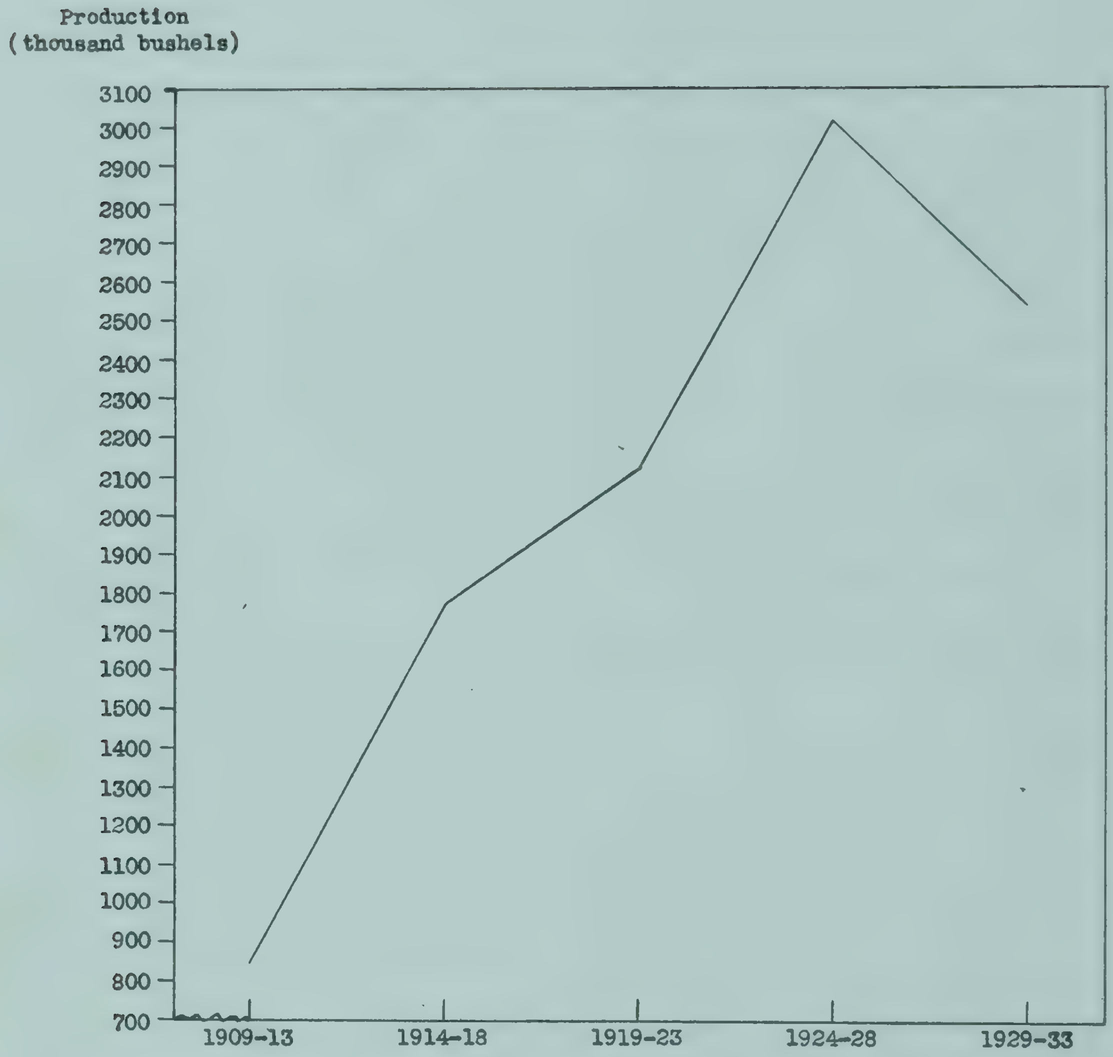

Fig. 2.—Production of Florida white potatoes in five-year averages.

FARMERS' COOPERATIVE ASSOCIATIONS IN FLORIDA

III. Business Analysis of the Hastings Potato Growers' Association[1]

By H. G. HAMILTON[2] and MARVIN A. BROOKER[3]

PURPOSE OF STUDY

The purpose of this study is to analyze the organization and the management policies of a relatively successful cooperative association engaged in the handling of Florida truck crops, in order to bring out, if possible, some of the experiences and practices which may prove helpful to other cooperatives engaged in similar undertakings. Because of the completeness and availability of its records, and the success of its most important activities, the Hastings Potato Growers' Association has been chosen for this study.

DEVELOPMENT OF THE POTATO INDUSTRY IN FLORIDA

The production of early white potatoes in Florida has expanded rapidly during the present century (Table 1). It is probable that the greater part of the Florida production at the beginning of the century was required for home consumption, so that commercial production at that time was small. In 1909 the production was 369 percent greater than it was in 1899. From the 1910-11 season to the 1915-16 season the production was quite uniform. Since the 1915-16 season production has been erratic, varying from 1,541,000 bushels for the 1931-32 season to

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Acknowledgments:—The writers wish to express their appreciation to the general manager, the secretary-treasurer and the bookkeeper of the Hastings Potato Growers' Association for their ready cooperation and assistance in making available the records which are the basis for this study. Much credit is due Dr. C. V. Noble, under whose direction this study was made.

[1] This is the third of a series of bulletins dealing with farmers' cooperative associations in Florida. In the first, Bulletin 245, was presented a classified list of the active and the inactive associations which had been organized in Florida prior to the 1931-32 marketing season, with some supplementary information gained from their charters and interviews, and a discussion of the principal Federal and State laws governing cooperative associations in Florida. The second in the series, Bulletin 263, dealt with the economic status and the organization and management policies of these associations.

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[3] Formerly Associate Agricultural Economist of the Florida Agricultural Experiment Station.

3,875,000 bushels for the 1927-28 season with an average production of 2,552,302 bushels for the period 1918-19 to 1932-33. The continuity of the increase from 1909 to 1933 is better shown in periods of five-year averages, Fig. 2.

TABLE 1.—PRODUCTION OF WHITE POTATOES IN FLORIDA[1].

Season or Year	Bushels	Season or Year	Bushels
1889	74,089	1920-21	1,564,000
1899	232,212	1921-22	2,860,000
1909	856,967	1922-23	1,748,000
1910-11	900,000	1924	2,429,014
1911-12	1,023,000	1924-25	2,852,000
1912-13	912,000	1925-26	2,832,000
1913-14	1,040,000	1926-27	3,045,000
1914-15	960,000	1927-28	3,875,000
1915-16	1,110,000	1929	2,714,323
1916-17	2,275,000	1929-30	2,560,000
1917-18	3,500,000	1930-31	3,640,000
1919	1,767,196	1931-32	1,541,000
1919-20	2,625,000	1932-33	2,232,000

[1] Data for census years are from the U. S. Census Reports. Data for 1910-11 to 1919-20 seasons are from the yearbooks of the United States Department of Agriculture for those years. Data for the 1920-21 and 1921-22 seasons are from the 1923 yearbook; 1922-23 to 1925-26 seasons from the 1926 yearbook; 1926-27 to 1929-30 seasons from the 1931 yearbook; 1930-31 and 1931-32 seasons from the 1933 yearbook; and 1932-33 season from the 1934 yearbook.

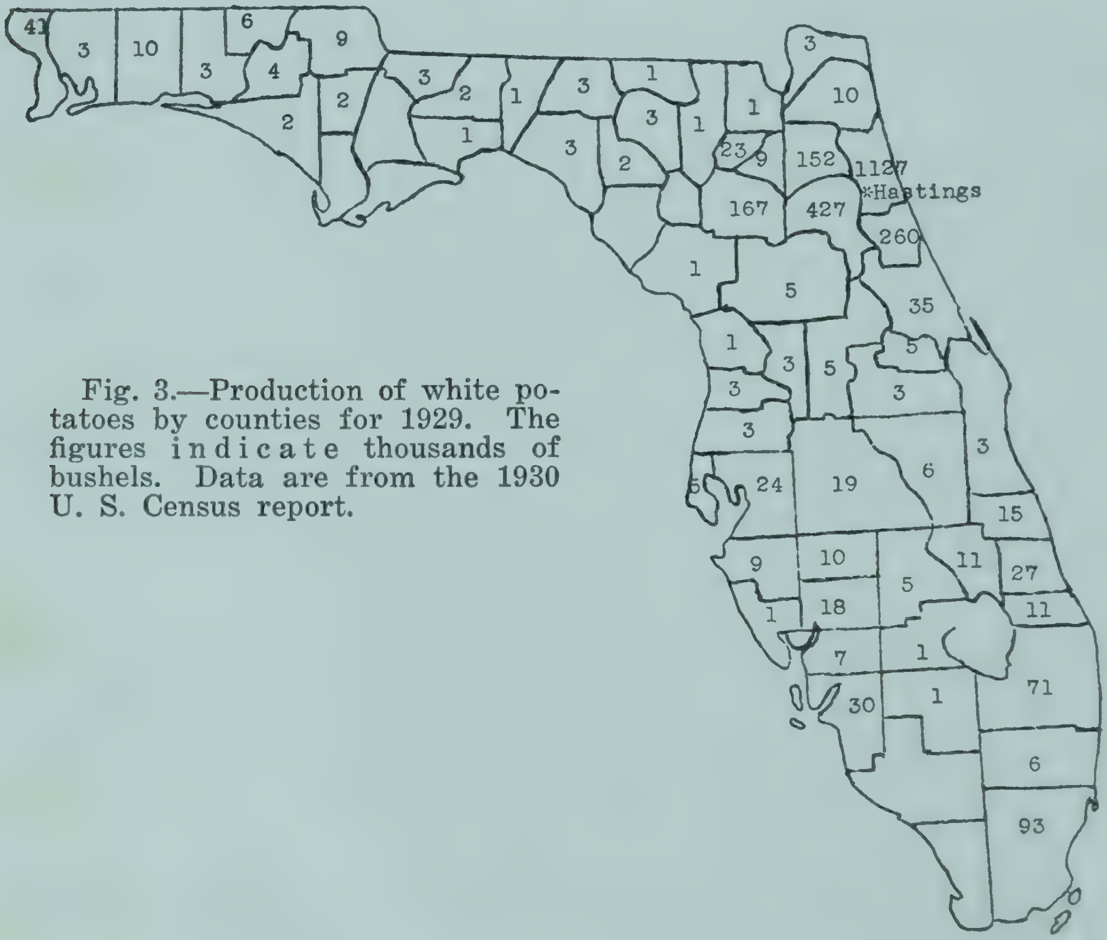

Fig. 3.—Production of white potatoes by counties for 1929. The figures indicate thousands of bushels. Data are from the 1930 U. S. Census report.

CONDITIONS LEADING TO THE ORGANIZATION OF THE HASTINGS POTATO GROWERS' ASSOCIATION

Early white potatoes are grown over a large part of the State of Florida, as indicated in Fig. 3, but the principal producing area is located in the northeastern part of the State, with Hastings as the principal shipping point. The importance of the Hastings potato area is illustrated in Table 2. Potato production began in this area in the late nineties, with small plantings a few miles south of Hastings. Real development of commercial potato growing began about 1910.

TABLE 2.—PRODUCTION OF WHITE POTATOES IN FLORIDA AND IN THE HASTINGS AREA BY CENSUS YEARS[1].

Year	Florida (bushels)	Hastings area[2] (bushels)	Percent Hastings area is of total
1889	74,089	3,633	4.9
1899	232,212	19,613	8.4
1909	856,967	542,685	63.3
1919	1,767,196	1,366,821	77.3
1924	2,429,014	1,512,529	62.3
1929	2,714,323	1,966,336	72.4

[1] U. S. Census Report.
[2] St. Johns, Putnam, Flagler and Clay counties.

The rapid increase in potato production during the decade which followed developed many complicated problems in connection with the financing of the crop in both production and marketing stages. Data computed from an economic study of 294 farms located in the Hastings area for the year 1925 indicate the importance of potatoes in this area, and the great amount of money required to produce and market a crop (Table 3).

TABLE 3.—ECONOMIC DATA OF 294 FARMS LOCATED IN THE HASTINGS AREA, 1925[1].

	Average per farm
Farm area	100.5 acres
Crop land	48.5 acres
Tillable land idle	6.9 acres
Potatoes	41.9 acres
Other first crops	6.6 acres
Second crops	38.7 acres
Total farm capital	$22,726
Total farm receipts	10,065
Receipts from potatoes	8,745
Total expenses	8,102
Fertilizer for potatoes	1,920
Seed potatoes	1,182
Containers for potatoes	1,318
Amount paid for labor	1,787

[1] McKinley, Bruce:—An Economic Study of Potato Farming in the Hastings Area for the Crop Year 1925. Florida Experiment Station Bulletin 193, 1928. (This Bulletin is now out of print.)

In an effort to solve some of the financing and marketing problems connected with this rapidly expanding industry, the Florida Potato Growers' Association was organized at Hastings in September, 1918. Not much could be learned regarding the operations of this association, except that it was intended to buy seed and fertilizer and sell potatoes for its members. It made no attempt to operate following the one season of 1918-19.

From the beginning it has been the practice of marketing firms to largely finance the potato enterprise. Because of the speculative nature of the crop and of the inexperience of many of the farmers, losses to middlemen were necessarily heavy. It was only logical that the dealers should make provisions in advance for such losses. One way of making provisions for losses incurred by the dealers was to charge a wide enough margin on supplies to cover these losses. Such a practice made it necessary for the efficient farmer to pay for the losses incurred by inefficient farmers. This should not be interpreted as unethical on the part of the dealer, since provisions for bad accounts are a legitimate operating expense. To make these provisions simply reflects good business practices on the part of the dealers. But such conditions led to a demand for an organization that would select credit risk, buy in quantities and thus lower the cost of producing and marketing potatoes for the efficient farmer.

It was felt, also, that a marketing organization owned and controlled by the growers and handling a considerable percentage of the crop would introduce a healthy competitive element into the potato deal.

As a result of these conditions and needs, a group of growers began discussing plans for setting up an organization for purchasing supplies and financing production and for marketing the potato crop.

No outside promoter was called in to aid in this movement. The initiative was taken entirely by the growers themselves and the sole objective was to bring in a factor that would lead to better conditions in the potato area. The modest amount of $179.25 appears on the profit and loss statement of the first year as organization expense.

These proposals began to take concrete form early in 1922, and resulted in the charter of the Hastings Potato Growers' Association in July, 1922. In connection with drawing up the charter for the Association, the cashier of the local bank was called upon for assistance. He rendered valuable service in setting up the organization and was made secretary-treasurer during the first year of operation.

ORGANIZATION OF THE ASSOCIATION

The Hastings Potato Growers' Association was incorporated under the Florida Cooperative Act of 1909 on July 1, 1922. On February 20, 1925, it was re-incorporated under the Florida Cooperative Marketing Act of 1923.

The purposes of the Association were to sell potatoes, to extend production credit and to supply seed, fertilizer and containers to its members. These have been the chief activities of the Association throughout the 12 years of its existence.

Each member is charged a membership fee of $15 upon joining the Association. At first there was a membership contract of three years' duration with no provision for withdrawal, but this has since been changed to 10 years with provision for withdrawal at the end of any season, provided the member is not financially obligated to the Association. There are no annual dues, and no fees for membership renewal, provided application is made for renewal at least 10 days before expiration of membership. The membership carries with it a crop contract and the by-laws contain a liquidated damage clause providing for the payment of one dollar per barrel for each barrel of potatoes sold outside the Association. There are no restrictions on purchasing supplies outside the Association.

The Association operates in four counties, namely, St. Johns, Flagler, Putnam and Clay. During the 1932-33 season, potatoes were loaded at 15 shipping points, including three boat landings on the St. Johns River.

THE INTERNAL ORGANIZATION

The Hastings Potato Growers' Association is governed by a board of directors composed of nine members elected for a period of three years on the one-member-one-vote principle. In this board is vested the authority and responsibility for the general supervision over all the affairs of the Association. Meetings are held monthly, but special meetings may be called by the president at any time. During the 1933-34 season the board met 15 times.

At the first regular meeting of the board of directors, officers are elected for the ensuing year. These consist of a president and a vice-president, who are members of the board of directors, and a secretary-treasurer who is a salaried employee and is not a director. It is not necessary that the secretary-treasurer be a member of the Association. The directors also employ a general manager and "such other employees as they deem necessary to the proper conduct of the business of the Association."

It is the duty of the secretary-treasurer to keep a record of the meetings of the members and of the board of directors and to have custody of the seal of the Association and of all its books and records. He is also the custodian of all funds of the Association, and is bonded in a reputable surety company in an amount determined by the board of directors.

The by-laws are indefinite as to the specific duties of the general manager. "The general manager shall, by and with the advice and consent of the board of directors, manage and direct the business affairs of this Association and he shall perform all duties as may, from time to time, be imposed upon him by the board of directors. He shall also supervise the pooling of prices * * *. The general manager shall see to it that the members of this Association are at all times kept informed with the utmost promptness, of the prices received for their products." The selling of potatoes, purchase of supplies, and pooling of prices appear to be the principal divisions of the duties of the general manager.

MARKETING OPERATIONS

Grading and Pooling. With the exception of the 1923, 1927, 1932, 1933 and 1934 seasons, the Association has used government inspection at shipping point (Fig. 4). Before the establishment of a central washing and grading plant in 1932 all potatoes were graded in the field by the individual farmer (Fig. 5). During the past three seasons almost one-half of the potatoes were graded at the packing plant while the remainder were graded in the field as formerly.

There are two reasons why government inspection was not used during the last three seasons. First, it was felt by the management that the members having packed under government inspection for several years were well informed as to what constituted government grades. Second, the installation of the packing plant made it possible to put up government grades under a trained employee.

The fact that the members who did their own packing were well informed as to the basis for government grades and that the packing plant was operated under the supervision of a trained

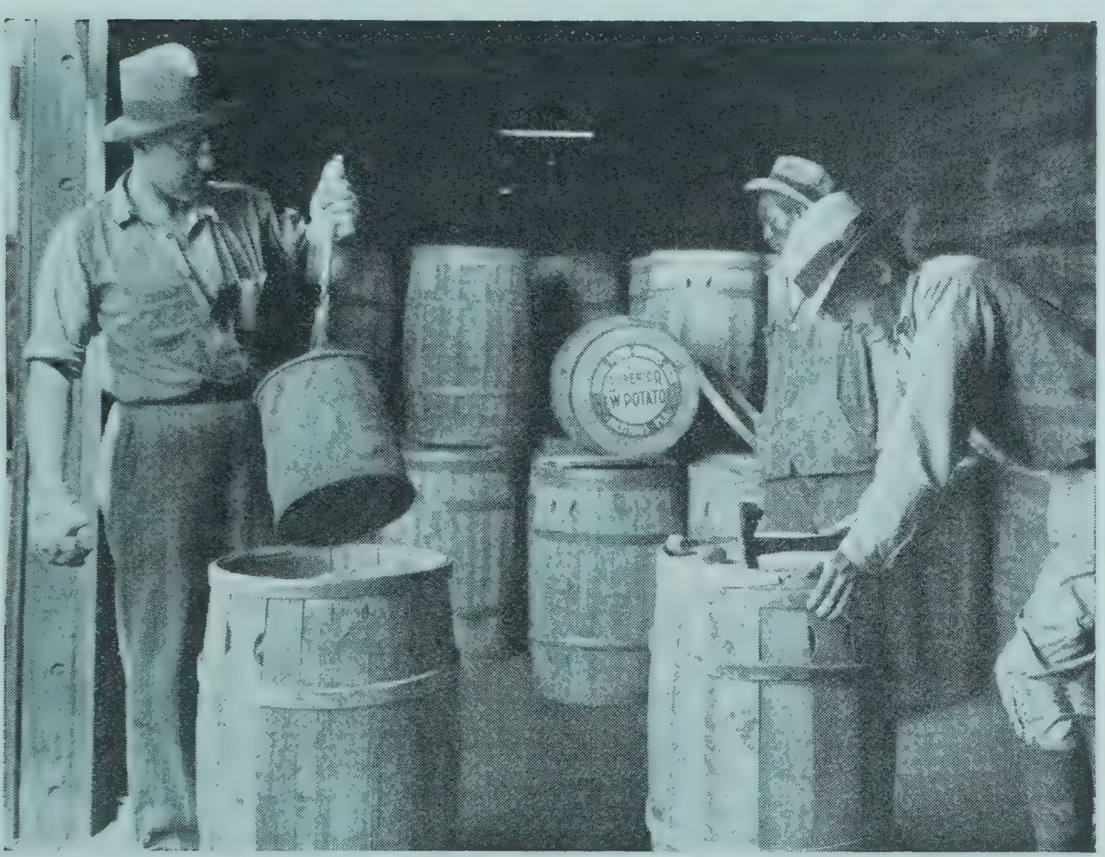

Fig. 4.—Federal inspectors inspecting and grading Hastings potatoes.

employee makes it possible for the salesmen to make their offerings on the basis of U. S. grades. In addition to an informed membership as to grades, a further factor that makes for success of this plan is to require that each member's potatoes bear a number. If it is found by customers or by terminal government inspection that any of the potatoes are not up to grade, the member's number on the potato container is secured, the lot taken out of the pool and the member made to bear all the loss of allowances made to the customer.

All U. S. No. 1 and No. 2 potatoes, and No. 3 when shipped, are pooled by grades into daily pools. Off-grades are not pooled. In making payment to members for potatoes sold, prices received are averaged in such way that each receives the approximate average price received for all potatoes of the same grade and loaded on the same day, provided the car is completed for shipment when the manifest of that day is closed. The railroad bill of lading governs the date of the pool unless the car was delayed by the Association. In that case the date of the loading is recorded and determines the pool.

Separate pools are made for field graded and for packinghouse graded potatoes. The use of the packing plant by members of the Association is optional. During the three seasons the packing plant has been in operation, an increasing percentage of potatoes has been put through it. It is the intent of the management that only the growers using the packing plant shall bear its expense, but, like any other department, any loss is absorbed by the Association proper. It is the experience of the past three seasons that potatoes graded and packed in the packing plant sold for enough more to largely offset the expense of the plant. It is questionable whether it actually costs any more to pack potatoes at the central plant than it does on the farm; however, the hauling from field to shipping point is more for some farmers since they would be able to load at a nearer point if the potatoes were not put through the packing plant.

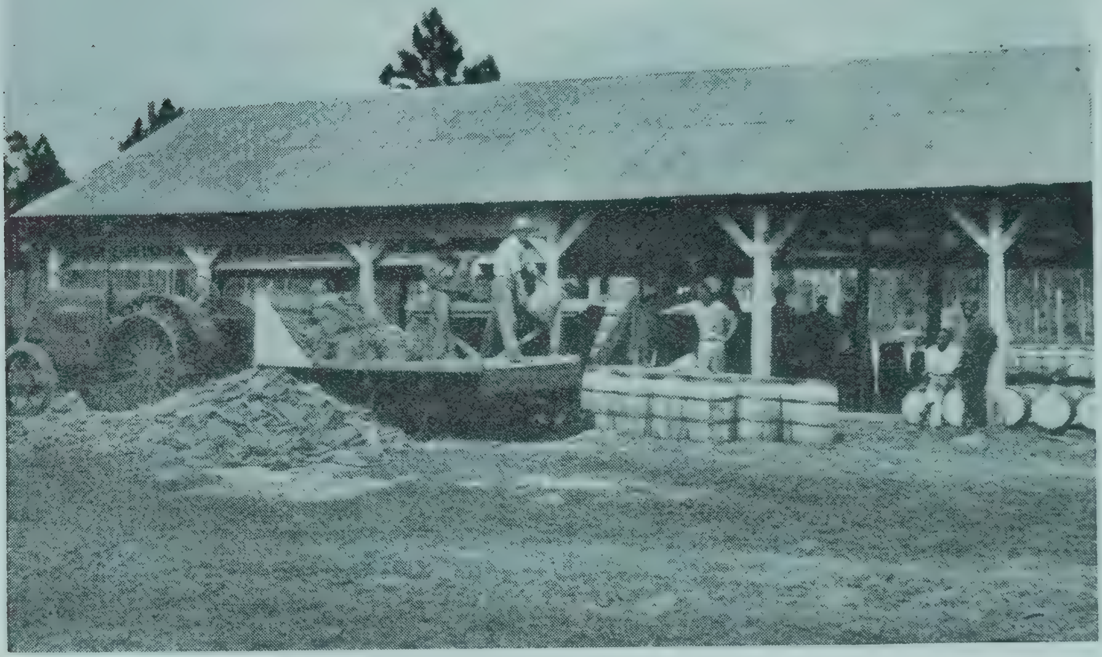

Fig. 5.—Grading and packing potatoes on a large farm near Hastings.

The management feels that there is a distinct advantage in the central packing plant in that a part of the trade demands a better pack than the average farmer can put up on the farm and it enables the Association to better fill the customer's needs. If customers desire solid cars of one grade or a certain type of container it is easier to supply them with their specific needs.

Expense of operating the packing plant is shown in Table 4.

The increase in the income and expense reflects the increased use of the packing plant. Increased depreciation expense (a fixed charge) in 1932-33 season over 1931-32 season was due to charging a higher depreciation rate while the increase for the 1933-34 season over the 1932-33 season was due to an increase in equipment.

TABLE 4.—COMPARATIVE PROFIT AND LOSS STATEMENTS OF THE WASHING AND PACKING PLANT OF THE HASTINGS POTATO GROWERS' ASSOCIATION, SEASONS 1931-32, 1932-33 AND 1933-34.

Season	1933–34	1932–33	1931–32
Income:			
Packing charges	$18,700.12	$ 7,700.86	$3,958.67
Loading charges	1,562.00	1,048.00	....
Sale of pick outs and culls	1,135.99	....	....
Miscellaneous sales	239.40	92.45	.70
Total operating income	$21,637.51	$ 8,841.31	$3,959.37
Expenses:			
Pay rolls	$12,234.96	$ 6,701.78	$2,298.54
Electricity	1,068.41	739.06	471.93
Telephone	29.55	21.42	23.05
Insurance	380.90	254.20	254.20
Nails, labels, tags, etc.	2,628.86	457.63	226.53
Miscellaneous	940.68	702.39	79.37
Depreciation	3,752.13	2,737.23	1,201.27
Total operating expenses	$21,035.49	$11,613.71	$4,554.89
Operating gain or loss	$ 602.02	–$2,772.40	–$595.52

As soon as the members' debts to the Association are liquidated they may draw all their money as fast as the pools are closed, except a retain of 10 cents per barrel which is held in abeyance until the end of the season to cover any unexpected allowance to customers. Pools are Association wide, and are practically always closed within three weeks after the potatoes are delivered to the Association.

Selling. The Association furnishes a loader and checker to supervise the loading of the cars and to check the number of barrels and the grade of potatoes placed in the car. As soon as the loading of a car is completed the checker's record is turned in to the Association. The manifest is then filled out and the car sold or consigned.

Each morning during the shipping season the Association, the leading independent shippers and a Federal-State agricultural extension worker meet for the purpose of determining the best schedule of prices to ask for shipments to be sold that day. Wires are then sent out to established connections in the markets of the country and offers made to sell at the schedule of prices established.

All available information is utilized in establishing the opening price, since it is essential that the correct price be asked. The correct price is one that will exactly move the supplies on hand. If too high a price is asked, some potatoes doubtless will be sold, but a number of unsold cars will accumulate and be added to the supply of the next day. When it becomes necessary to reduce the schedule of prices during the day, allowances are made to those customers who bought earlier in the day at the higher prices. But if it becomes necessary to raise the price during the day the customers who buy early do not have to pay the advanced price. This practice is important as it encourages customers to purchase early, since they are protected against price declines during the day and they stand a chance of getting their potatoes at a lower price than if they wait until late in the day. This makes for an active market early in the day.

When potatoes are not sold at the shipping point they are usually consigned to the order of the Association at some railway diversion point, such as Waycross, Georgia, Cincinnati or Potomac Yards. While enroute to this point the Association attempts to complete a sale and divert the car to the purchaser. The preference is to sell the potatoes for a definite price f. o. b. shipping point, but if this cannot be done, then an arrangement is made with the purchaser whereby payment is made on the basis of the prevailing price at the time the potatoes are received in the market. If the sale cannot be consummated in either way, the car is consigned to a commission merchant.

During each of two seasons, 1929-30 and 1932-33, 91 percent of the total cars of potatoes that graded U. S. No. 1 or U. S. No. 2 was sold f. o. b. shipping point and the remaining 9 percent was sold price arrival, or the prevailing price on the market at time of arrival. Off grade (not meeting U. S. grades) potatoes are usually sold on consignment.

During the 1929-30 season distribution was made by the Hastings Potato Growers' Association to 21 states and 92 markets; for the 1930-31 season, 20 states and 115 markets were entered; for the 1931-32 season, 21 states and 62 markets; for the 1932-33 season, 20 states and 86 markets; and for the 1933-34 season, 20 states and 80 markets. Shipments were made to the District of Columbia and points in Canada each of the seasons from 1929-30 to 1933-34. Distribution of potatoes of the

Hastings Potato Growers' Association is compared with the total distribution from Florida in Table 5.

TABLE 5.—DISTRIBUTION OF POTATOES FROM FLORIDA AND THE HASTINGS POTATO GROWERS' ASSOCIATION AVERAGE FOR FIVE SEASONS (1929-30 TO 1933-34[1] INCLUSIVE).

	Florida			Hastings Potato Growers' Association		
	Cars		Markets	Cars		Markets
	Number	Percent		Number	Percent	
Alabama	9.4	.28	2.6	1.8	.16	.8
California	1.2	.03	.6	---------	---------	---------
Colorado	.2	.01	.2	---------	---------	---------
Connecticut	11.6	.35	2.4	12.2	1.07	2.0
Delaware	1.0	.03	.4	1.2	.11	.4
Florida	77.4	2.31	2.6	3.0	.26	1.4
Georgia	84.4	2.52	7.4	11.0	.96	4.0
Illinois	55.8	1.67	1.6	16.2	1.42	1.2
Indiana	11.6	.35	2.4	3.6	.32	1.6
Kansas	.4	.01	.2	---------	---------	---------
Kentucky	3.8	.11	1.4	1.0	.09	.6
Louisiana	1.4	.04	.4	---------	---------	---------
Maryland	132.4	3.95	1.2	33.4	2.93	1.0
Massachusetts	100.4	3.00	2.6	32.4	2.84	2.2
Michigan	120.0	3.58	3.6	55.2	4.84	2.8
Minnesota	2.0	.06	.6	---------	---------	---------
Missouri	7.6	.23	1.6	.4	.04	.2
New Jersey	145.8	4.35	6.0	84.4	7.39	4.4
New York	970.4	28.98	15.0	351.0	30.75	14.8
North Carolina	95.4	2.85	15.4	49.2	4.31	14.2
Ohio	175.8	5.25	7.2	74.0	6.48	6.2
Oklahoma	.2	.01	.2	---------	---------	---------
Oregon	.2	.01	.2	---------	---------	---------
Pennsylvania	824.4	24.62	13.6	292.4	25.62	9.8
Rhode Island	10.0	.30	1.4	9.0	.79	1.4
South Carolina	55.4	1.65	7.8	20.6	1.80	5.2
Tennessee	31.0	.93	3.4	15.4	1.35	3.6
Texas	.2	.01	.2	---------	---------	---------
Vermont	1.0	.03	1.0	.4	.03	.2
Virginia	301.6	9.00	8.0	19.8	1.73	5.4
Washington	1.4	.04	.8	---------	---------	---------
Washington, D. C.	63.4	1.89	1.0	23.4	2.05	1.0
West Virginia	11.4	.34	3.4	4.6	.40	2.8
Wisconsin	4.6	.14	.8	3.4	.30	.8
Canada	36.0	1.07	3.8	22.4	1.96	3.4
Total	3348.8	100.00	121.0	1141.4	100.00	91.4

[1] Data for Florida distribution were taken from mimeographed reports of Marketing Hastings Potatoes, as published by the Federal-State Market News Service. These reports do not always show final destination of cars since shippers often bill the cars to some diversion point and then divert them to other markets, consequently, states (Florida, Georgia, Virginia, and Ohio) with principal diversion points show more receipts than were actually unloaded. Data for the Hastings Potato Growers' Association were taken from the records of the Association and are for final destination.

The Association accepts the responsibility for making collection after a commitment is made. Usually a bank draft is drawn on the purchaser at the time of the sale, but ordinarily the bill of lading is not attached to the draft. If it becomes impossible to make a collection the loss is charged against the surplus of the Association.

The net sale of potatoes and the charges made by the Association for handling potatoes is shown by seasons in Table 17.

The expense of selling is itemized by years in Table 6. It will be observed from this table that brokers were the chief sales agents of the Association throughout the period. The range in brokerage expense was from $10,143.99 to $28,898.00 and amounted to from 42 percent to 71 percent of the total expense of selling. Telephone and telegraph charges were an important item of expense and fluctuated less than the brokerage expense. Since brokerage is charged on a car basis, it is influenced by the volume of potatoes sold, while most of the telephone and telegraph bill is made in wiring out the daily offerings of the Association which requires about as much for a small as for a large crop.

A considerable amount was saved each of the last three years by not using government inspection at the shipping point. The small inspection expense for these years represents inspection at the terminal markets. Less was also spent for advertising during the last three years than in previous years. The expense of selling per barrel varied from 8.9 cents for the 1925-26 season to 15.3 cents for the 1928-29 season and averaged 12.1 cents for the seasons 1924-25 to 1933-34, inclusive.

Field Department. The principal duties of the field department are to advise with members as to fertilizer requirements, kind and application of spray materials, and to assist them with their harvesting, grading and packing operations. The field man may also advise as to the type of soil and cultural practices for potatoes.

It is not a function of the field department to solicit new members or to engage in propaganda for the Association.

In addition to the services rendered directly to the membership, the field department keeps the sales manager advised as to the probable supplies that will be offered by the members not only for the day, but for several days in advance.

The expense of the field department for the seasons 1925-26 to 1933-34, inclusive, is shown in Table 7.

TABLE 6.—SELLING EXPENSE OF THE HASTINGS POTATO GROWERS' ASSOCIATION.

Season	1933-34	1932-33	1931-32	1930-31	1929-30	1928-29	1927-28	1926-27	1925-26	1924-25
Expense:										
Salaries	$ 1,303.93	$ 2,032.50	$ 4,458.36	$ 3,267.73	$ 6,458.47	$ 6,622.33	$ 8,437.75	....	$ 460.00	$ 3,171.21
Brokerage	18,877.44	15,535.71	10,143.99	17,682.50	11,993.00	21,537.10	28,898.00	$23,001.50	13,149.00	13,889.50
Telephone and telegraph	2,771.28	2,658.11	2,656.93	3,892.96	3,279.62	4,024.83	5,171.93	4,482.61	3,963.95	3,574.87
Advertising	669.70	364.75	166.35	963.55	1,255.95	1,079.40	1,603.90	1,657.30	1,501.56	1,089.71
Inspection	13.00	146.86	94.50	1,271.40	3,605.00	6,025.00	8,436.59	....	3,674.74	4,257.50
Travel	498.00	566.26	812.36	2,983.72	1,636.28	2,099.00	2,956.33	2,885.76	580.75	694.20
Office supplies, printing, postage, etc.	503.31	504.27	646.77	405.99	478.68	1,465.31	1,425.58	1,148.72	774.27	31.00
Total	$24,636.66	$21,808.46	$18,979.26	$30,467.85	$28,707.00	$42,852.97	$56,930.08	$33,175.89	$24,104.27	$26,707.99
Expense per barrel	$.110	$.113	$.148	$.100	$.146	$.153	$.132	$.109	$.089	$.113

TABLE 7.—FIELD DEPARTMENT EXPENSE OF THE HASTINGS POTATO GROWERS' ASSOCIATION.

Season	1933-34	1932-33	1931-32	1930-31	1929-30	1928-29	1927-28	1926-27	1925-26
Expense:									
Salaries	$1,325.00	$1,700.00	$3,158.71	$6,346.50	$5,749.59	$4,792.50	$3,411.67	$4,242.50	$3,856.66
Gas, oil, auto repairs and licenses	537.82	712.04	1,228.91	964.65	1,449.27	1,262.69	1,907.06	1,353.52	584.38
Auto depreciation	333.68	168.13	324.63	122.32	365.88	365.88	....	350.00	160.50
Miscellaneous expense	....	2.50	159.85	42.08	78.69	58.76	20.25	18.95	....
Total	$2,196.50	$2,582.67	$4,872.10	$7,475.55	$7,643.43	$6,479.83	$5,338.98	$5,964.97	$4,601.54

Non-Member Business. As a rule the Hastings Potato Growers' Association does not sell potatoes for non-members. However, at some time during most seasons it is necessary for the Association to buy some potatoes to meet outstanding orders. Also, during some seasons it has acted as sales agent for smaller associations. In such cases a fixed rate per car is charged for this sales service, and the returns may or may not be pooled with the regular Association sales, depending upon whether or not the potatoes are graded according to Association standards. The number of equivalent barrels of potatoes handled for members of the Association and the number handled for non-members or purchased to fill orders during each season from 1922-23 to 1933-34, inclusive, are shown in Table 8.

TABLE 8.—NUMBER OF EQUIVALENT BARRELS OF POTATOES HANDLED FOR MEMBERS OF THE HASTINGS POTATO GROWERS' ASSOCIATION, AND NUMBER HANDLED FOR NON-MEMBERS OR PURCHASED TO FILL ORDERS, SEASONS 1922-23 TO 1933-34, INCLUSIVE.

Season	Members	Non-Members	Total
1922-23	110,362	....	110,362
1923-24	171,119	22,541	193,660
1924-25	236,051	9,848	245,899
1925-26	235,632	34,283	269,915
1926-27	278,226	27,167	305,393
1927-28	396,879	35,965	432,844
1928-29	270,625	10,323	280,948
1929-30	195,311	1,911	197,222
1930-31	296,830	8,177	305,007
1931-32	112,732	15,145	127,877
1932-33	190,754	2,221	192,975
1933-34	223,413	412	223,825
Average	226,494	14,000	240,494

PURCHASE OF SUPPLIES AND PRODUCTION CREDIT

A member of the Hastings Potato Growers' Association is bound by contract to sell his potatoes through the Association. While there are no such restrictions for the purchasing of supplies through the Association, it is the exception that a member buys his supplies from other sources.

It was observed in Table 3 that the average expense in the Hastings area per farm for fertilizer, seed and containers was $4,420 in 1925. For the 12-year period in which the Hastings Potato Growers' Association has operated an average of $1,336.39 per member per year was advanced for production and harvest-

TABLE 9.—VOLUME OF BUSINESS OF THE HASTINGS POTATO GROWERS' ASSOCIATION FOR EACH YEAR OF OPERATION.

Season	Sales of Potatoes	Supplies								Cash Advanced	
				Containers							
	(Equivalent barrels)	Ferti-lizer (tons)	Seed (11-peck sacks)	11-peck barrels	50-pound tubs	Hampers	11-peck sacks	Dust (pounds)	Miscel-laneous (dollars)	For Labor Before Harvest	For Harvest Labor
1922-23	110,362	2,701	14,180	99,000	....	....	11,000	....	....	$ 48,396.73	$ 57,020.60
1923-24	193,660	6,500	34,000	200,000	....	....	....	144,100	....	98,560.00	112,693.50
1924-25	245,899	4,750	29,777	206,950	....	....	....	170,000	$ 2,059	78,717.30	134,120.18
1925-26	269,915	5,149	27,556	231,582	....	5,700	12,462	183,150	3,708	90,327.40	121,672.87
1926-27	305,393	7,139	39,100	270,398	....	46,500	....	401,800	23,396	126,500.00	156,793.50
1927-28	432,844	8,128	43,115	277,281	....	133,000	83,600	424,350	10,497	125,958.10	246,043.53
1928-29	280,948	5,664	29,735	234,735	....	....	40,035	211,590	2,830	88,948.70	127,517.35
1929-30	197,222	7,586	40,107	235,838	3,000	....	27,501	390,400	8,089	115,685.52	96,546.42
1930-31	305,007	6,427	37,786	222,636	....	27,617	29,222*	248,150	6,798	82,573.85	141,789.12
1931-32	127,877	3,830	22,768	119,191	....	....	33,820**	164,595	1,770	57,126.89	30,488.51
1932-33	192,975	3,280	20,122	132,332	17,752†	....	123,325††	178,212	5,814	41,893.00	43,110.00
1933-34	223,825	5,021	25,734	129,113	53,148†	....	25,734‡ 148,267‡‡	242,800	7,013	48,008.25	58,872.89
Average	240,494	5,515	30,332	196,588				229,929	$ 5,998	$ 83,557.98	$110,555.71

* No 11-peck sacks used. Total made up of 27,412 100-pound sacks and 1,810 50-pound sacks.

** No 11-peck sacks used. All 50-pound sacks.

† 50-pound boxes.

†† No 11-peck sacks used. Total made up of 105,573 100-pound sacks and 17,752 50-pound sacks.

‡ 11-peck sacks.

‡‡ 100-pound sacks.

ing. During the same period supplies (fertilizer, seed, containers, spray materials, etc.) sold averaged $3,506.77 per member. More than 95 percent of the supplies were sold to members on credit. The quantities of the various supplies and cash advanced are shown in Table 9, while the value of supplies is shown in Table 17. The Association pays cash for all supplies it handles. After the Association ascertains the amount and analysis of fertilizer needed the secretary notifies fertilizer firms that the Association will receive bids on their fertilizer requirements on a specified date. Representatives from firms may, if they prefer, appear before the board of directors and make their bid orally. Similar negotiations are made for spray materials and containers. Seed potatoes are purchased in Maine, a representative of the Association inspecting them while growing.

In order to extend these credit services, it has been necessary for the Association to be cautious about its credit risk and to make adequate provisions for losses, which always occur in an undertaking of this kind.

The credit structure of the Association is based on two funds, the growers' reserve fund and the sinking fund.

The Growers' Reserve Fund. The growers' reserve fund is built up by making a reserve charge for each unit of supplies sold to members on credit, and whether the member purchases his supplies on a cash or credit basis a reserve charge of 5 cents per barrel is made for each barrel of potatoes sold for him. The most usual reserve charges have been as follows:

Fertilizer—$4 per ton.
Seed potatoes—50 cents per 11-peck sack.
Dust—50 cents per 100 pounds.
Containers—3½ to 5 cents per 11-peck barrel or equivalent.
Selling—5 cents per 11-peck barrel or equivalent.

During the depression period some of these reserve charges were lowered in approximate proportion to the lower price of the supplies.

The growers' reserve charge of 5 cents per barrel for each barrel of potatoes handled by the Association ranged from 0.6 percent of the sales of potatoes for the 1925-26 season to 2 percent for the 1932-33 season and averaged 1.1 percent for the 12 seasons. The purpose of this part of the growers' reserve fund retain is for a basis of credit for cash loaned members for production and harvest labor. The percent that this retain is of the cash advanced to members is shown in Table 10. It will be observed that it ranged from 4.5 percent for the 1922-23 season to 11.2 percent for the 1932-33 season, with an average of 5.9 percent.

TABLE 10.—RELATION OF THE GROWERS' RESERVE RETAIN FOR SELLING TO THE CASH ADVANCED FOR PRODUCTION AND HARVESTING.

Season	Cash Advanced for Labor		Total Cash Advanced	Growers' Reserve Retain for Selling	Percent Growers' Reserve Retain for Selling Is of Cash Advanced
	Before Harvest	Harvest			
1922-23	$ 48,396.73	$ 57,020.60	$ 105,417.33	$ 4,746.67	4.5
1923-24	98,560.00	112,693.50	211,253.50	10,988.00	5.2
1924-25	78,717.30	134,120.18	212,837.48	11,012.18	5.2
1925-26	90,327.40	121,672.87	212,000.27	11,787.08	5.6
1926-27	126,500.00	156,793.50	283,293.50	15,269.65	5.4
1927-28	125,958.10	246,043.53	372,001.63	19,843.95	5.3
1928-29	88,948.70	127,517.35	216,466.05	13,531.25	6.2
1929-30	115,685.52	96,546.42	212,231.94	9,765.55	4.6
1930-31	82,573.85	141,789.12	224,362.97	15,250.35	6.8
1931-32	57,126.89	30,488.51	87,615.40	6,393.85	7.3
1932-33	41,893.00	43,110.00	85,003.00	9,504.96	11.2
1933-34	48,008.25	58,872.89	106,881.14	8,572.00	8.0
Total	$1,002,695.74	$1,326,668.47	$2,329,364.21	$136,665.49	5.9
Average	$ 83,557.98	$ 110,555.71	$ 194,113.68	$ 11,388.79	5.9

The purpose of the growers' reserve fund obtained by making a charge for the various supplies sold to members is to give a basis of credit so that the Association may purchase these supplies for cash. That portion of the growers' reserve fund secured by a charge for each unit of supplies sold on credit varied from 6.5 percent of the sale of supplies for the 1933-34 season to 10.6 percent for the 1931-32 season with an average of 8.1 percent for the 12 seasons (Table 17).

The Farm Credit Act of 1933 requires each member of a production credit association to own an amount of stock in the Production Credit Association equal in fair book value (not exceeding par) to 5 percent of the loan received. A reserve of 5.9 percent of the cash advanced to members and a reserve of 8.1 percent of the sale value of supplies have been required by the Hastings Potato Growers' Association. If a member of a production credit association pays his loan each year or as it falls due he is not required to subscribe to additional stock for a succeeding loan unless the loan is greater than any previous loan he has been granted. But in the case of the Hastings

TABLE 11.—COMPARISON OF THE CASH ADVANCED AND SALE VALUE OF SUPPLIES TO THE GROWERS' RESERVE FUND AT THE END OF THE SEASON.

Season	Acres of Potatoes	Cash Advanced	Sale Value of Supplies	Cash Advanced and Sale of Supplies		Balance in Growers' Reserve Fund End of Season		Percent Growers' Reserve Fund is of Cash Advanced and Value of Supplies for the Season
				Total	Per Acre	Total	Per Acre	
1922-23	2,701	$ 105,417.33	$ 222,995.34	$ 328,412.67	$121.59	$ 22,453.11	$ 8.32	6.8
1923-24	5,655	211,253.50	598,387.47	809,640.97	143.17	74,428.58	13.16	9.2
1924-25	5,789	212,837.48	529,403.45	742,240.93	128.22	126,521.28	21.86	17.0
1925-26	5,023	212,000.27	564,212.92	776,213.19	154.53	175,519.72	34.94	22.6
1926-27	6,700	283,293.50	791,313.54	1,074,607.04	160.39	184,871.96	27.59	17.2
1927-28	7,824	372,001.63	849,572.07	1,221,573.70	156.13	280,001.31	35.79	22.9
1928-29	5,906	216,466.05	525,310.02	741,776.07	125.60	286,239.76	48.46	38.6
1929-30	7,766	212,231.94	763,734.10	975,966.04	125.67	353,131.46	45.47	36.2
1930-31	6,400	224,362.97	542,668.72	767,031.69	119.85	417,466.29	65.23	54.4
1931-32	4,480	87,615.40	253,746.40	341,361.80	76.20	450,783.83	100.62	132.0
1932-33	3,980	85,003.00	206,169.74	291,172.74	73.16	479,472.40	120.47	164.7
1933-34	4,791	106,881.14	289,329.38	396,210.52	82.70	379,066.50	79.12	95.7
Total	67,015	$2,329,364.21	$6,136,843.15	$8,466,207.36	$126.33			
Average	5,584	$ 194,113.68	$ 511,403.60	$ 705,517.28	$126.33			

Potato Growers' Association these reserves are required for each succeeding year until his reserve equals $75.00 per acre for his current crop of potatoes. In addition to this the growers' note to the Association is secured by a crop lien and a real estate mortgage.

The amount of cash advanced to members and the sale value of supplies is compared with the balance in the growers' reserve fund at the end of each season (Table 11). The maximum value of cash advanced and supplies was $160.39 per acre for the 1926-27 season, while the smallest amount for cash advanced and supplies was $73.16 for the 1932-33 season, and the average was $126.33 per acre.

The growers' reserve fund starting at $8.32 per acre for the first season increased to $120.47 per acre for the 1932-33 season. On account of a drastic writing off of notes through the growers' reserve fund it was lowered to $79.12 per acre at the end of the 1933-34 season. The percent that the growers' reserve fund was of the cash advanced and sale of supplies is shown in the last column of Table 11. The growers' reserve fund at the end of the 1922-23 season was only 6.8 percent of the cash advanced and sale of supplies during that season, while in the 1932-33 season it was 164.7 percent. This is a marked increase in the reserves of the Association. But, from 1929-30 to 1933-34 season the Association carried over a considerable amount in growers' notes, which offsets to some extent the seeming strength of the reserve fund.

Obviously the test of strength of the credit structure for growers of the Association is the percent that the growers' reserve fund is of the combined values of the cash advanced and sale of supplies for the current year plus the carry-over of growers' notes from previous years. In order to show this clearly, Table 12 has been prepared. It will be noted that the greatest burden per acre occurred in the 1925-26 season, when there was an average of $166.16 per acre in cash advanced, sale of supplies and growers' notes from the previous season. During the 1932-33 season the growers' reserve fund was 73.6 percent of the combined amount of cash advanced, sale of supplies and growers' notes carried over.

In June, 1934, a drastic writing off of growers' notes through the growers' reserve fund reduced the growers' reserve fund to 55.7 percent of the combined value of cash advanced, sale of supplies and growers' notes carried over from the previous season. This represents a rather remarkable position of strength,

TABLE 12.—COMPARISON OF CASH ADVANCED, SUPPLIES SOLD AND GROWERS' NOTES CARRIED OVER WITH THE GROWERS' RESERVE FUND.

Season	Acres of Potatoes	Cash Advanced and Sale of Supplies	Growers' Notes from Previous Season	Cash Advanced and Sale of Supplies Plus Growers' Notes Carried Over from Previous Season		Balance in Growers' Reserve Fund End of Season	Percent Growers' Reserve Fund Is of Cash Advanced, Sale of Supplies and Growers' Notes Carried Over
				Total	Per Acre		
1922-23	2,701	$ 328,412.67	....	$ 328,412.67	$121.59	$ 22,453.11	....
1923-24	5,655	809,640.97	$ 10,851.62	820,492.59	145.09	74,428.58	9.1
1924-25	5,789	742,240.93	55,803.21	798,044.14	137.86	126,521.28	15.8
1925-26	5,023	776,213.19	58,422.84	834,636.03	166.16	175,519.72	21.0
1926-27	6,700	1,074,607.04	6,271.74	1,080,878.78	161.32	184,871.96	17.1
1927-28	7,824	1,221,573.70	45,539.24	1,267,112.94	161.95	280,001.31	22.1
1928-29	5,906	741,776.07	209,759.58	951,535.65	161.11	286,239.76	30.1
1929-30	7,766	975,966.04	67,481.19	1,043,447.23	134.36	353,131.46	33.8
1930-31	6,400	767,031.69	200,180.36	967,212.05	151.13	417,466.29	43.2
1931-32	4,480	341,361.80	328,827.32	670,189.12	149.60	450,783.83	67.3
1932-33	3,980	291,172.74	360,666.25	651,838.99	163.78	479,472.40	73.6
1933-34	4,791	396,210.52	284,433.26	680,643.78	142.07	379,066.50	55.7

particularly when the abnormal conditions that prevailed from 1929 to 1934 are considered.

The only uses that may be made of the growers' reserve fund are for making investments and covering of losses in the accounts of individual growers. The fund is invested in stock of the Hastings Agricultural Credit Corporation, which is a subsidiary of the Hastings Potato Growers' Association, and in government bonds or other gilt edge investments.

The by-laws have the following provision in regard to covering losses in growers' accounts. "The Board of Directors shall at its discretion have authority to cover shortages as may exist in growers' accounts at the close of any season's business, out of the funds available in the reserve fund, provided that the grower whose account shows such shortage first gives to the Association a legal promissory note for the full amount of such shortage, together with a crop lien on his or her following year's crop, . . . upon payment of such note or notes, the principal sum thereof shall revert back to the reserve fund."

On March 21, 1934, the by-laws were changed to give the directors authority upon three-fourths majority to " . . . enter into a contract or contracts to purchase . . . . from any member of this Association his net equity in the reserve fund, or to prevent said board of directors from transferring any and all such equities in the reserve fund of the Association so purchased to the sinking fund of the Association." This authority was exercised before the close of the 1933-34 season, Table 13.

When the net equities of the members in the Growers' Reserve Fund shall exceed $300,000 the board of directors may distribute on a revolving basis if they deem it to the best interest of the Association all or any part of the amount in excess of $300,000. However, no grower who does not have a net balance of $75.00 per acre of potatoes on the basis of his current crop may participate in the refund. This provision tends to make for stability of membership, as a grower who has the most uninterrupted affiliation with the Association would receive his refund quicker than one with broken membership in the Association.

The total refunds to growers at the close of the 1933-34 season amounted to $126,521.28, but on July 1, 1934, a refund of $99,303.32 was made. All additions to the growers' reserve fund and the distribution out of the fund are shown by years in Table 13.

Members who pay cash for their supplies are required to pay only 25 percent of the regular growers' reserve fund. The reason it is necessary for cash buyers to contribute to the reserve fund is that a considerable period of time elapses from the date the Association makes its purchases until it delivers the supplies to its members.

TABLE 13.—STATUS OF THE GROWERS' RESERVE FUND, 1922-23 TO 1933-34, INCLUSIVE.

Season	Additions to Fund	Distribution of Fund				Balance in Fund End of Season
		Growers	Applied on Growers' Notes Charged Off	Growers' Reserves Purchased and Charged to the Sinking Fund	Adjustments, etc.	
1922-23	$ 22,453.11	....	....	....	....	$ 22,453.11
1923-24	51,975.47	....	....	....	....	74,428.58
1924-25	52,092.70	....	....	....	....	126,521.28
1925-26	55,756.26	$ 6,757.82	....	....	....	175,519.72
1926-27	77,023.00	67,670.76	....	....	....	184,871.96
1927-28	95,129.35	....	....	....	....	280,001.31
1928-29	58,331.15	52,092.70	....	....	....	286,239.76
1929-30	66,891.70	....	....	....	....	353,131.46
1930-31	64,334.83	....	....	....	....	417,466.29
1931-32	33,317.54	....	....	....	....	450,783.83
1932-33	28,688.57	....	....	....	....	479,472.40
1933-34	27,508.12	*	$103,814.10	$ 23,191.85	$908.07	379,066.50
Total	$633,501.80	$126,521.28	$103,814.10	$ 23,191.85	$908.07	

* Refunded to growers on July 1, 1934, $99,303.32.

Members whose reserve fund exceeds their credit needs are required to pay only 25 percent of the regular growers' reserve fund charge. This provision is made in order that the members' reserve fund and credit needs be kept in adjustment.

At the end of a season if a grower owes less than the amount of his reserve fund he does not pay interest on the carry-over paper. In case the member owes more than his reserve amounts to, he pays interest on carry-over paper only on the amount that his debt exceeds his reserve. Prior to the 1933-34 season the grower was required to pay interest on his carry-over paper regardless of the amount of his reserve.

The Sinking Fund. For the purpose of taking care of losses in accounts of the Association the sinking fund was established in 1926. The sinking fund may draw its resources from the following sources: (1) Interest on bonds and interest paid to the Association by growers for cash advances and for credit on supplies. (2) From recovery on notes previously charged off. (3) At the discretion of the board of directors transfers from the operating account of the Association may be made. (4) Profits from the purchase of growers' reserves may be added to the sinking fund. The sinking fund is used primarily to cover losses in growers' accounts and to pay interest on money borrowed by the Association, however, any losses occurring in the operation of the Association may at the will of the board of directors be covered out of the sinking fund.

The status of the sinking fund from the time it was established to June, 1934, is shown in Table 14.

It is significant that the interest income of the Association exceeds the interest paid by the Association in an amount which is almost sufficient to take care of bad accounts of the Association. The rate of interest charged the grower is about 1 percent less than the commercial interest rate in this area. This means that the Association has been able to attract capital at a low rate of interest.

Credit Risk of Members. Where extensive credit is granted, it is of interest to the management to determine as far as possible the type of member that is a good credit risk.

In order to throw some light on this problem the membership of the Hastings Potato Growers' Association was divided into three groups. First those who were out of debt to the Association, second those who were in debt to the Association but whose reserves exceeded their debt, and third those whose debt to the Association exceeded their reserves. The average acres of potatoes, yield and debt to the Association for each of these groups is shown for two seasons in Table 15.

It will be observed that the group that was out of debt to the Association at the end of the 1932-33 season had an average of 40.4 acres of potatoes per member while the group of members whose debt exceeded their reserves had an average of 25.6 acres of potatoes. The debt of the latter group ranged from $146.68 to $14,341.88 and averaged $5,004.54. But they had reserves in the Association which averaged $3,011.74 per member, which would leave an average net debt of $1,992.80. For the 1933-34 season the average member out of debt had 41.9 acres of potatoes while the group of members whose debt exceeded their reserves had only 26.6 acres of potatoes. The debt of the group of members whose debt exceeded their reserves ranged from $1,183.82 to $6,497.12 and averaged $4,020.40. The group of members

TABLE 14.—STATUS OF SINKING FUND, SEASONS 1925-26 TO 1933-34, INCLUSIVE.

Season	ADDITIONS TO FUND FROM					DISTRIBUTION OF FUND TO					Balance End of Season
	Interest[1]	Recovery on Notes Previously Charged Off	Operating Fund	Profit on Reserve Funds Purchased	Total Additions	Interest	Notes and Accounts Charged Off	Cash in Closed Banks Charged Off	Other	Total Deductions	
1925-26			$ 629.75		$ 629.75						$ 629.75
1926-27	$ 4,791.96	$ 1,457.31		$ 217.15	6,466.42						7,096.17
1927-28	11,394.08	3,168.38			14,562.46		$ 2,140.75			$ 2,140.75	19,517.88
1928-29	22,434.41	1,257.55		400.95	24,092.91		14,154.14	$ 1,810.96	$ 3,605.70	19,570.80	24,039.99
1929-30	22,402.54		10,000.00		32,402.54		42,334.79	6,924.14		49,258.93	7,183.60
1930-31	26,938.84	3,122.07			30,060.91		12,704.64	6,924.14	1,418.01	21,046.79	16,197.72
1931-32	29,517.53				29,517.53	$ 15,297.75	2,739.25	2,855.88		20,892.88	24,822.37
1932-33	18,698.45		10,000.00	151.78	28,850.23	7,675.19	34,120.76		263.58	42,059.53	11,613.07
1933-34	12,838.82	9,006.91	11,000.00	7,911.23	40,756.96	10,300.56	39,245.37		1,311.01	50,856.94	1,513.09
Total	$149,016.63	$ 18,012.22	$ 31,629.75	$ 8,681.11	$207,339.71	$ 33,273.50	$147,439.70	$ 18,515.12	$ 6,598.30	$205,826.62	

[1] Data for seasons 1926-27 to 1930-31 are for net interest.

TABLE 15.—STATUS OF MEMBERS' DEBT TO THE ASSOCIATION FOR TWO SEASONS.

Season	1932-33			1933-34		
	Members Out of Debt to the Association	Members in Debt but Reserves Exceed Debt in the Association	Members Whose Debt Exceeds Their Reserves in the Association	Members Out of Debt to the Association	Members in Debt but Reserves Exceed Debt in the Association	Members Whose Debt Exceeds Their Reserves in the Association
Number	60	30	28	76	18	19
Average acres of potatoes	40.4	27.8	25.6	41.9	36.7	26.6
Average number barrels of potatoes	1,916.4	1,334.5	1,241.3	1,977.1	1,684.3	1,080.0
Average yield per acre	47.4	48.0	48.4	47.1	45.9	40.6
Average amount of reserve	$2,603.42	$2,775.03	$3,011.74	$2,494.96	$3,360.58	$2,140.67
Average amount of debt		1,215.30	5,004.54		1,862.83	4,020.40
Net balance per member	$2,603.42	$1,559.73	–$1,992.80	$2,494.96	$1,497.75	–$1,879.73

who were in debt to the Association but whose reserves exceeded their debt had fewer acres of potatoes on the average than the group out of debt, but more than the group of members whose debt exceeds their reserves. It appears that volume of business, even in these seasons of low potato prices, was an important factor in successful potato farming.

During a period of unusual depression as has occurred from 1929 to 1934 it is but natural for farmers to turn to some other crop or livestock enterprise than that which they have been accustomed to producing. It would seem from the data in Table 15 that some of the members of the Hastings Potato Growers' Association attempted to better themselves by partially abandoning potatoes for some other enterprise.

Data were secured on 105 members for the 1933-34 season, showing the acres in each member's farm available (i.e. suitable) for potatoes, the actual acres planted to potatoes, and his debt to the Association at the close of the 1933-34 season (Table 16). Thirteen farmers planted all of their available potato land to potatoes and rented additional land for potatoes; 20 members planted all of their available potato land to potatoes, but did not rent any additional land; 32 members planted from 75.1 to 99.9 percent of their available potato land to potatoes; 28 members planted from 50.1 to 75.0 percent of their available potato land to potatoes and 12 members planted 50 percent or less of their available potato land to potatoes. The percent of the available potato land planted to potatoes is shown for each group. The data show that the group planting 50 percent or less of their available potato land to potatoes on the average had 44 percent more land available for potatoes than the group planting 100 percent of their available potato land to potatoes, but actually planted 31 percent fewer acres of potatoes per farm.

For each group as the percent of available potato land planted to potatoes was decreased there was a tendency for the percent of the members in debt to the Association to increase and the average amount of the debt to the Association to increase. The average reserves for each group not planting all of their available potato land were greater than the average reserves of the group of 20 members who planted to potatoes all of their available potato land. This indicates that in former years their acreage must have been greater than the average acreage for the 1933-34 season or such reserves could not have been built up.

TABLE 16.—RELATION OF THE PERCENT OF AVAILABLE POTATO LAND PER FARM PLANTED TO POTATOES FOR 1933-34 SEASON TO MEMBERS' DEBT, END OF 1933-34 SEASON.

Available Potato Land Planted to Potatoes	Number of Farms	Number of Farms in Debt to the Association	Percent of Farms in Debt to the Association	Acres of Potato Land Available for Potatoes per Farm	Acres of Potatoes Planted per Farm	Percent of Available Potato Land Planted to Potatoes	Average Debt to Association per Farm	Average Reserve per Member	Amount Reserves Exceed Debt
Over 100 percent..........	13	2	15.4	34.8	65.7[1]	188.5[1]	$ 896.89	$3,176.16	$2,279.27
100 percent	20	2	10.0	41.6	41.6	100.0	129.10	1,789.77	1,660.67
75.1-99.9 percent	32	9	28.1	42.1	36.8	87.4	650.42	2,952.00	2,301.58
50.1-75.0 percent	28	16	57.1	53.1	34.1	64.3	1,495.68	2,604.11	1,108.43
50.0 percent and less....	12	6	50.0	73.8	28.6	38.8	2,232.10	2,304.40	72.30
Total	105	35	33.3	....	....	....	....	....	....
Average......................	....	....	....	47.6	39.6	83.2	$ 987.80	$2,591.59	$1,603.79

[1] Some farmers planted all of their owned land in potatoes and rented additional land for potatoes.

TWELVE YEARS OPERATIONS AS SHOWN BY PROFIT AND LOSS STATEMENTS

The operations of the Hastings Potato Growers' Association may be studied by years from the profit and loss statements, Table 17.

The sale of potatoes reached a peak of $2,005,673.83 for the 1925-26 season and then declined to only $472,020.59 for the 1932-33 season. The greater part of this shrinkage was due to a drastic decrease in the price of potatoes. However, there was a considerable decrease in acreage.

The maximum sale of supplies amounted to $849,572.07 for the 1927-28 season and decreased to $206,169.74 for the 1932-33 season.

Operating expenses reached a peak of $95,386.82 for the 1927-28 season and declined to $44,387.16 for the 1932-33 season. General and administrative expense fluctuates from year to year much less than selling expense. There was considerable variation in the field and loading expense due to the installation of the packing plant which enabled these departments to cut their expenses in about the same proportion that the potatoes packed in the packing plant were of the total potatoes handled.

On the whole, the Association's expenses were within the charges that were set up for operation. A net operating income was shown seven out of 12 seasons. The total net income available for distribution (excluding the net interest income) during the 12 years amounted to $62,028.84. Distribution of the operating income was as follows: transferred to sinking fund $31,629.75, bad debts charged off $15,023.77, refunded to growers $9,537.15, and the remaining $5,838.17 was left in the surplus account at the close of the 1933-34 season.

The charges for selling were 22 cents per barrel, except for the 1933-34 season when a charge of only 17 cents per barrel was made. The charges ranged from 3.2 percent of the sales of potatoes for the 1925-26 season to 8.9 percent for the 1932-33 season with an average of 5.2 percent for the 12 seasons. Prior to the 1926-27 season no charges were made for handling supplies for members, but the cost of performing this service was borne by the marketing charge. Charges since the 1925-26 season for handling of supplies have varied from 0.9 percent of the sale of supplies for the 1926-27 season to 3.5 percent for the 1933-34 season, with an average of 2.2 percent for the eight seasons.

TABLE 17.—PROFIT AND LOSS STATEMENTS OF THE HASTINGS POTATO GROWERS' ASSOCIATION.

Season	1933-34		1932-33		1931-32		1930-31	
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Net sales of potatoes	$ 777,902.32	100.0	$ 472,020.59	100.0	$ 519,656.23	100.0	$1,004,464.76	100.0
2. Association marketing charge	44,536.12	5.7	41,926.41	8.9	27,772.09	5.3	66,711.59	6.6
3. Growers' reserve fund retain[1]	8,572.00	1.1	9,504.96	2.0	6,393.85	1.2	15,250.35	1.5
4. Building revolving fund retain[2]	2,508.67	.3	5,915.11	1.3	3,379.78	.7	8,913.97	.9
5. Packing plant revolving fund retain[3]	4,592.88	.6	1,925.44	.4	2,336.35	.5	....	....
6. Net payment to members	$ 717,692.65	92.3	$ 412,748.67	87.4	$ 479,774.16	92.3	$ 913,588.85	91.0
7. Net supplies furnished	$ 289,329.38	100.0	$ 206,169.74	100.0	$ 253,746.40	100.0	$ 542,668.72	100.0
8. Association charges for handling supplies	10,025.70	3.5	7,028.85	3.4	8,384.28	3.3	14,831.12	2.7
9. Growers' reserve fund retain[1]	18,936.12	6.5	19,183.61	9.3	26,923.69	10.6	49,084.48	9.0
10. Cost of supplies furnished	$ 260,367.56	90.0	$ 179,957.28	87.3	$ 218,438.43	86.1	$ 478,753.12	88.3
11. Other operating income	$ 11,299.19		$ 2,592.84		$ 249.87		$ 169.00	
12. Total operating income[4]	$ 65,861.01	100.0	$ 51,548.10	100.0	$ 36,406.24	100.0	$ 81,711.71	100.0
General and Administrative Expense:								
13. Salaries	$ 7,247.79	11.2	$ 4,891.24	9.5	$ 10,900.81	29.9	$ 15,022.66	18.4
14. Telephone and telegraph	281.69	.4	417.87	.8	713.72	1.9	3,267.23	4.0
15. Office supplies and postage	680.15	1.0	650.12	1.3	792.62	2.2	455.75	1.0
16. Magazines and periodicals	153.00	.2	141.50	.2	505.50	1.4	1,259.55	1.2
17. Legal and audit	764.60	1.2	654.82	1.3	1,137.20	3.1	1,203.28	1.5
18. Insurance and licenses	589.67	.9	1,699.79	3.3	1,443.29	4.0	1,138.84	1.4
19. Taxes	1,545.62	2.4	539.65	1.0	83.60	*	1,605.08	1.9
20. Depreciation office, cottage and garage buildings	2,024.88	3.0	2,024.88	3.9	2,024.88	5.6	684.72	.8
21. Depreciation equipment	677.39	1.0	674.87	1.3	688.72	1.9	411.74	.5
22. General advertising	....	....	....	....	....	....		
23. Rent	....	....	....	....	240.00	.7	....	....
24. Other	5,165.89	7.8	6,211.31	12.1	5,881.58	16.3	987.73	1.2
25. Total general and administrative expense	$ 19,130.67	29.1	$ 17,906.05	34.7	$ 24,411.92	67.0	$ 26,036.58	31.9
26. Selling	24,636.66	37.4	21,808.46	42.3	18,979.26	52.2	30,467.85	37.3
27. Field	2,196.50	3.3	2,582.67	5.0	4,872.10	13.4	7,475.55	9.1
28. Loading potatoes on cars	2,301.62	3.5	2,089.98	4.1	1,019.37	2.8	4,370.38	5.3
29. Total operating expense	$ 48,265.45	73.3	$ 44,387.16	86.1	$ 49,282.65	135.4	$ 68,350.36	83.6
30. Net operating income	$ 17,595.56	26.7	$ 7,160.94	13.9	–$12,876.41	–35.4	$ 13,361.35	16.4
31. Other income	9,857.86		490.50		945.15		2,415.04	
32. Other expense	11,398.07		222.67		1,874.52		....	
33. Net income	$ 16,055.35		$ 7,428.77		–$13,805.78		$ 15,776.39	
34. Adjustment account gain or loss	–752.36		105.40		–6,552.87		1,729.82	
35. Income for distribution	$ 15,302.99		$ 7,534.17		–$20,358.65		$ 17,506.21	
36. Carried to sinking fund	$ 11,000.00		$ 10,000.00		....		....	
37. Refunded to members	9,537.15		....		....		....	
38. Bad debts written off	....		....		....		....	
39. Gain or loss to surplus	–5,234.16		–2,465.83		–$20,358.65		$ 17,506.21	

*Less than one-tenth of one percent.

[1] Carried to growers' reserve fund.

[2] Carried to building revolving fund.

[3] Carried to packing plant revolving fund.

[4] Total of lines 2, 8 and 11.

TABLE 17.—PROFIT AND LOSS STATEMENTS OF THE HASTINGS POTATO GROWERS' ASSOCIATION (continued).

Season		1929-30		1928-29		1927-28		1926-27	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1.	Net sales of potatoes	$ 921,700.99	100.0	$1,317,737.28	100.0	$1,351,510.07	100.0	$1,460,809.50	100.0
2.	Association marketing charge	43,251.04	4.7	59,491.73	4.5	92,256.82	6.8	65,453.85	4.5
3.	Growers' reserve fund retain[1]	9,765.55	1.1	13,531.25	1.0	19,843.95	1.5	15,269.65	1.0
4.	Building revolving fund retain[2]	5,872.91	.6	8,118.27	.6	12,064.49	.9	8,346.28	.6
5.	Packing plant revolving fund retain[3]	....	....	....	....	....	....	....	....
6.	Net payment to members	$ 862,811.49	93.6	$1,236,596.03	93.9	$1,227,344.81	90.8	$1,371,739.72	93.9
7.	Net supplies furnished	$ 763,734.10	100.0	$ 525,310.02	100.0	$ 849,572.07	100.0	$ 791,313.54	100.0
8.	Association charges for handling supplies	17,658.34	2.3	10,868.53	2.1	15,890.19	1.9	6,879.02	.9
9.	Growers' reserve fund retain[1]	57,126.15	7.5	44,799.90	8.5	75,285.40	8.9	61,753.35	7.8
10.	Cost of supplies furnished	$ 688,949.61	90.2	$ 469,641.59	89.4	$ 758,396.48	89.2	$ 722,681.17	91.3
11.	Other operating income	$ 113.93		$ 134.34		$ 158.85		$ 115.11	
12.	Total operating income[4]	$ 61,023.31	100.0	$ 70,494.60	100.0	$ 108,305.86	100.0	$ 72,447.98	100.0
	General and Administrative Expense:								
13.	Salaries	$ 15,617.66	25.6	$ 16,038.71	22.8	$ 13,553.83	12.5	$ 17,412.56	24.0
14.	Telephone and telegraph	3,357.01	5.5	2,973.65	4.2	3,847.07	3.6	4,505.33	6.2
15.	Office supplies and postage								
16.	Magazines and periodicals	425.75	.7	411.00	.6	247.36	.2	235.50	.3
17.	Legal and audit	752.93	1.2	591.60	.8	544.10	.5	857.00	1.2
18.	Insurance and licenses	1,593.00	2.6	639.78	.9	652.30	.6	1,298.94	1.8
19.	Taxes	531.69	.9	689.30	1.0	172.54	.2	74.77	.1
20.	Depreciation office, cottage and garage buildings	1,605.08	2.6	1,605.08	2.3	1,605.08	1.5	....	....
21.	Depreciation equipment	672.89	1.1	662.03	.9	586.69	.5	530.21	.7
22.	General advertising	292.25	.5	253.00	.4	504.02	.4	763.80	1.1
23.	Rent	....	....	....	....	....	....	256.50	.4
24.	Other	988.89	1.6	883.40	1.2	1,287.96	1.2	1,181.20	1.6
25.	Total general and administrative expense	$ 25,837.15	42.3	$ 24,747.55	35.1	$ 23,000.95	21.2	$ 27,115.81	37.4
26.	Selling	28,707.00	47.1	42,852.97	60.8	56,930.08	52.6	33,175.89	45.8
27.	Field	7,643.43	12.5	6,479.83	9.2	5,338.98	4.9	5,964.97	8.2
28.	Loading potatoes on cars	4,225.77	6.9	4,396.09	6.2	10,116.81	9.4	6,488.95	9.0
29.	Total operating expense	$ 66,413.35	108.8	$ 78,476.44	111.3	$ 95,386.82	88.1	$ 72,745.62	100.4
30.	Net operating income	-$5,390.04	-8.8	-$7,981.84	-11.3	$ 12,919.04	11.9	-$297.64	-.4
31.	Other income	488.05		347.89		2,458.04		930.00	
32.	Other expense	....		....		....		....	
33.	Net income	-$4,901.99		-$7,633.95		$ 15,377.08		$ 632.36	
34.	Adjustment account gain or loss	5,204.86		3,625.23		1,522.52		1,861.75	
35.	Income for distribution	$ 302.87		-$4,008.72		$ 16,899.60		$ 2,494.11	
36.	Carried to sinking fund	$ 10,000.00		....		....		....	
37.	Refunded to members	....		....		....		....	
38.	Bad debts written off	....		....		....		....	
39.	Gain or loss to surplus	-9,697.13		-$4,008.72		$ 16,899.60		$ 2,494.11	

[1] Carried to growers' reserve fund.
[2] Carried to building revolving fund.
[3] Carried to packing plant revolving fund.
[4] Total of lines 2, 8 and 11.

TABLE 17.—PROFIT AND LOSS STATEMENTS OF THE HASTINGS POTATO GROWERS' ASSOCIATION (concluded).

Season	1925-26		1924-25		1923-24		1922-23	
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1. Net sales of potatoes	$2,005,673.83	100.0	$1,012,070.50	100.0	$1,009,082.17	100.0	$ 554,448.71	100.0
2. Association marketing charge	63,196.76	3.2	59,154.83	5.8	51,106.25	5.1	27,705.30	5.0
3. Growers' reserve fund retain[1]	11,787.08	.6	11,012.18	1.1	10,988.00	1.1	4,746.67	.9
4. Building revolving fund retain[2]	....	....	....	....	....	....	....	....
5. Packing plant revolving fund retain[3]	....	....	....	....	....	....	....	....
6. Net payment to members	$1,930.689.99	96.2	$ 941,903.49	93.1	$ 946,987.92	93.8	$ 521,996.74	94.1
7. Net supplies furnished	$ 564,212.92	100.0	$ 529,403.45	100.0	$ 598,387.47	100.0	$ 222,995.34	100.0
8. Association charges for handling supplies	....	....	....	....	....	....	....	....
9. Growers' reserve fund retain[1]	43,969.18	7.8	41,080.52	7.8	40,987.47	6.8	17,706.44	7.9
10. Cost of supplies furnished	$ 520,243.74	92.2	$ 488,322.93	92.2	$ 557,400.00	93.2	$ 205,288.90	92.1
11. Other operating income	$ 618.06		$ 1,595.64		....		$ 846.05	
12. Total operating income[4]	$ 63,814.82	100.0	$ 60,750.47	100.0	$ 51,106.25	100.0	$ 28,551.35	100.0
General and Administrative Expense:								
13. Salaries	$ 14,004.15	21.9	$ 15,002.72	24.7	....	....	$ 4,932.63	17.3
14. Telephone and telegraph } 15. Office supplies and postage }	5,704.17	8.9	4,452.00	7.3	....	....	1,485.50	5.2
15. Office supplies and postage	....	....	....	....	....	....	....	....
16. Magazines and periodicals	55.00	.1	159.12	.3	....	....	11.50	.1
17. Legal and audit	....	....	....	....	....	....	....	....
18. Insurance and licenses	....	....	....	....	....	....	....	....
19. Taxes	....	....	....	....	....	....	....	....
20. Depreciation office, cottage and garage buildings	574.98	.9	300.23	.5	....	....	64.28	.2
21. Depreciation equipment	514.32	.8	585.70	1.0	....	....	....	....
22. General advertising	562.50	.9	850.00	1.4	....	....	425.85	1.5
23. Rent	2,730.81	4.3	3,369.71	5.5	....	....	187.01	.6
24. Other					....	....		
25. Total general and administrative expense	$ 24,145.93	37.8	$ 24,719.48	40.7	....	....	$ 7,106.77	24.9
26. Selling	24,104.27	37.8	26,707.99	44.0	....	....	15,061.80	52.8
27. Field	4,601.54	7.2	5,427.65	8.9	....	....	2,669.34	9.3
28. Loading potatoes on cars	5,458.14	8.6						
29. Total operating expense	$ 58,309.88	91.4	$ 56,855.12	93.6	$ 52,033.05	101.8	$ 24,837.91	87.0
30. Net operating income	$ 5,504.94	8.6	$ 3,895.35	6.4	–926.80	–1.8	$ 3,713.44	13.0
31. Other income	5,431.12		7,268.86		17.92		1,055.00	
32. Other expense	233.32		....		....		....	
33. Net income	$ 10,702.74		$ 11,164.21		–$908.88		$ 4,768.44	
34. Adjustment account gain or loss	629.75		....		....		....	
35. Income for distribution	$ 11,332.49		$ 11,164.21		–$908.88		$ 4,768.44	
36. Carried to sinking fund	$ 629.75		....		....		....	
37. Refunded to members	....		....		....		....	
38. Bad debts written off	15,023.77		....		....		....	
39. Gain or loss to surplus	–4,321.03		$ 11,164.21		–$908.88		$ 4,768.44	

[1] Carried to growers' reserve fund.
[2] Carried to building revolving fund.
[3] Carried to packing plant revolving fund.
[4] Total of lines 2, 8 and 11.

STATUS OF ASSOCIATION AT END OF EACH SEASON AS SHOWN BY BALANCE SHEET

The position of the Hastings Potato Growers' Association at the end of each season may be obtained from the balance sheet, Table 18. Attention is directed to the current ratio which reflects the current strength of the Association insofar as being able to meet the current liabilities of the Association. With the exception of the 1931 and 1932 years which were fair, the Association was in an unusually strong current financial position.

The growth of the fixed assets of the Association indicates its policy in regard to fixed investments. The Association at the end of the first season's operation had the moderate amount of $578.52 in equipment, which was the total amount of all fixed assets. The Association continued to rent office space until the 1926-27 season when it purchased an office site and put a two-story office building on it (Fig. 1). At the close of the 1925-26 season a sufficient amount of cash was on hand to warrant the acquisition of office real estate. A building revolving fund was set up during the 1926-27 season for the purpose of refunding the money which was used from the surplus and reserve accounts of the Association.

The building revolving fund represents a deduction from the sale of potatoes of 3 cents per barrel for each barrel of potatoes sold through the Association from the 1926-27 season through the 1932-33 season. This deduction of 3 cents per barrel was formerly fixed by the by-laws, but on March 21, 1934, the by-laws were amended so that a deduction of not less than 1 nor more than 3 cents per barrel should be made each year. During the 1930-31 season deduction at 3 cents per barrel reached an amount equal to the value of the office real estate. The next year a refund was made for the amount that the building revolving fund was in excess of the value of the office real estate. It is the intent that each year a refund will be made in an amount equal to deductions for the current year, the refunds being made in the order accumulated. The building revolving fund may be used only for liquidating the debt for the office real estate, refunds to growers in order accumulated and to cover directly or indirectly through the sinking fund shortages in members' accounts. The status of the building revolving fund is shown in Table 19.

When in the judgment of the management the markets were demanding a better pack than was being obtained from the field pack, a packing plant was built. Although the packing plant was built at a time when there was need for economy, as more than $300,000.00 in growers' notes were carried over from the 1930-31 season, the fact that it was used voluntarily by members to such an extent that it was necessary to enlarge it for the 1933-34 season seems to have justified its erection.

The packing plant revolving fund operates on the same principle as the building revolving fund. Each year a deduction is made for the potatoes that are packed in the packing plant. A fixed deduction per barrel is not provided for in the by-laws, but is determined by the board of directors. Like the building revolving fund, the packing plant revolving fund may be used to liquidate the packing plant debt, to make refunds to growers and to cover directly or indirectly through the sinking fund shortages in growers' accounts. The status of the packing plant revolving fund may be observed in Table 20.

The large amount of growers' notes carried over from time to time and particularly during the depression years illustrates the need for a large reserve fund for an association that undertakes credit services for a highly speculative industry. The Association has been successful in keeping a large part of the growers' notes secured by mortgages and/or reserves. There is a distinct advantage in having the real estate mortgage in addition to the crop lien for it discourages growers from abandoning the crop when it appears that the crop will not pay for the outstanding debt against it. Too often Farmers' Cooperative Associations in Florida have accepted as security for cash and supplies furnished a member's note secured only by a crop lien. The member is naturally inclined to abandon the crop if he thinks it is not going to liquidate the debt against it, and depend on making other marketing and production contacts for future years.

If the collateral required is in excess of the debt against the crop the grower will make every effort to get all out of the crop that it will return in order to save his collateral. Each current loan is secured by a crop lien and a real estate mortgage. The extent that notes carried over have been secured by mortgages and reserves is shown for each year at the bottom of the balance sheet, Table 18.

TABLE 18.—COMPARATIVE BALANCE SHEETS OF THE HASTINGS POTATO GROWERS' ASSOCIATION AS OF JUNE.

Year	1934			1933			1932		
	ASSETS								
	Amount		Percent	Amount		Percent	Amount		Percent
Current Assets:									
Cash		$ 73,460.31			$ 68,525.35			$ 53,948.52	
Accounts receivable		3,287.92		$ 65,980.24			$ 32,902.31		
Notes receivable	$152,225.75			284,433.26			360,666.25		
Less: Notes discounted	151,808.99	416.76		122,119.94			105,829.83		
Provision for bad debts				31,108.78	197,184.78		73,093.65	214,645.08	
Judgments		....			....			....	
Claims		....			....			....	
Other current assets		16.30							
Total current assets		$ 77,181.29	17.5		$265,710.13	42.0		$268,593.60	43.2
Deferred Assets:									
Advance on seed		$ 7,401.62			$ 10,475.00			....	
Supplies inventory		8,106.55			8,167.42			$ 4,246.14	
Total deferred assets		$ 15,508.17	3.5		$ 18,642.42	3.0		$ 4,246.14	.7
Fixed Assets:									
Office equipment		$ 1,900.48			$ 2,552.67			$ 3,217.92	
Automobile		1,263.84			311.72			851.55	
Revolving fund		....			....			....	
Buildings		24,580.33			26,261.07			28,285.95	
Farm equipment		....			....			291.22	
Packing plant		35,625.63			22,274.46			23,376.46	
Office site and other real estate		22,275.34			30,475.60			26,334.11	
Total fixed assets		$ 85,645.62	19.4		$ 81,875.52	12.9		$ 82,357.21	13.3
Other Assets:									
Reserve fund purchased		....			$ 1,194.67			$ 1,194.67	
Stocks		$249,100.00			249,100.00			249,100.00	
Bonds		9,409.75			8,700.00			8,700.00	
Cash in litigation		4,000.00			6,647.98			6,695.29	
Net value of life insurance		230.34			800.00			280.00	
Total other assets		$262,740.09	59.6		$266,442.65	42.1		$265.969.96	42.8
Total Assets		$441,075.17	100.0		$632,670.72	100.0		$621,166.91	100.0

TABLE 18.—COMPARATIVE BALANCE SHEETS OF THE HASTINGS POTATO GROWERS' ASSOCIATION AS OF JUNE (continued).

Year	1934			1933			1932		
	LIABILITIES AND MEMBERS' EQUITY								
	Amount		Percent	Amount		Percent	Amount		Percent
Current Liabilities:									
Accounts payable		$ 6,129.16			....			$ 1,546.92	
Notes payable		6,256.60			$110,130.51			160,221.60	
Other current liabilities		....			912.33			609.37	
Total current liabilities		$ 12,385.76	2.8		$111,042.84	17.6		$162,377.89	26.2
Members' Equity:									
Reserve for losses		....			....			....	
Sinking fund		$ 1,513.09			$ 11,613.07			$ 24,822.37	
Growers' reserve for distribution		379,066.50			479,472.40			450,783.83	
Building revolving fund		34,016.23			46,317.07			40,401.96	
Packing plant revolving fund		8,255.42			4,261.79			2,336.35	
Surplus		5,838.17			11,072.33			13,538.16	
Total		$428,689.41			$552,736.66			$531,882.67	
Less: Reserve for doubtful accounts	....			$31,108.78			$73,093.65		
Experimental farm losses	....	....		....	31,108.78		....	73,093.65	
Total members' equity		$428,689.41	97.2		$521,627.88	82.4		$458,789.02	73.8
Total Liabilities and Members' Equity		$441,075.17	100.0		$632,670.72	100.0		$621,166.91	100.0
Number of notes overdue		54			61			96	
Amount of notes overdue secured by:									
Stock		$ 900.00			$ 900.00			$ 900.00	
Mortgages and reserves		151,325.75			280,875.07			357,417.13	
Amount of notes unsecured		....			2,658.19			2,349.12	
Current ratio		6.23 :1			2.39 :1			1.65 :1	

TABLE 18.—COMPARATIVE BALANCE SHEETS OF THE HASTINGS POTATO GROWERS' ASSOCIATION AS OF JUNE (continued).

Year	1931			1930		1929		1928	
	ASSETS								
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Current Assets:									
Cash		$ 59,562.70		$ 1,006.79		$155,522.72		$ 36,467.81	
Accounts receivable	$ 43,236.72			1,379.80		9,373.74		11,258.96	
Notes receivable	328,827.32			200,180.36		67,481.19		209,759.58	
Less: Notes discounted	94,690.87								
Provision for bad debts	43,372.25	234,000.92							
Judgments				918.01		918.01		918.01	
Claims									
Other current assets								370.65	
Total current assets		$293,563.62	47.0	$203,484.96	49.1	$233,295.66	63.4	$258,775.01	66.8
Deferred Assets:									
Advance on seed		$ 2,867.40		$ 7,495.43					
Supplies inventory		5,073.67		11,184.08		$ 4,671.34		$ 4,679.59	
Total deferred assets		$ 7,941.07	1.3	$ 18,679.51	4.5	$ 4,671.34	1.3	$ 4,679.59	1.2
Fixed Assets:									
Office equipment		$ 3,742.89		$ 4,309.37		$ 4,841.41		$ 5,314.71	
Automobile		1,176.18				914.69		1,518.07	
Revolving fund				500.00		682.50		1,365.00	
Buildings		30,173.03		31,551.63		36,266.18		38,052.51	
Farm equipment		423.68							
Packing plant									
Office site and other real estate		23,551.92		20,400.45		12,973.91		3,490.51	
Total fixed assets		$ 59,067.70	9.5	$ 56,761.45	13.8	$ 55,678.69	15.1	$ 49,740.80	12.9
Other Assets:									
Reserve fund purchased									
Stocks		$249,100.00		$ 99,100.00		$ 74,100.00		$ 74,100.00	
Bonds		200.00		16,500.00					
Cash in litigation		13,892.85		19,265.03					
Net value of life insurance		240.00		190.00					
Total other assets		$263,432.85	42.2	$135,055.03	32.6	$ 74,100.00	20.2	$ 74,100.00	19.1
Total Assets		$624,005.24	100.0	$413,980.95	100.0	$367,745.69	100.0	$387,295.40	100.0

TABLE 18.—COMPARATIVE BALANCE SHEETS OF THE HASTINGS POTATO GROWERS' ASSOCIATION AS OF JUNE (continued).

Year		1931		1930		1929		1928	
	LIABILITIES AND MEMBERS' EQUITY								
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Current Liabilities:									
Accounts payable		$ 274.78		$ 61.95		....		$ 14,179.02	
Notes payable		156,708.03		2,811.39		$ 2,849.17		23,089.97	
Other current liabilities		883.45		....		....		....	
Total current liabilities		$157,866.26	25.3	$ 2,873.34	.7	$ 2,849.17	.8	$ 37,268.99	9.6
Members' Equity:									
Reserve for losses		....		....		....		....	
Sinking fund		$ 16,197.72		$ 7,183.60		$ 24,039.99		$ 19,517.88	
Growers' reserve for distribution		417,466.29		353,131.46		286,239.76		280,001.31	
Building revolving fund		43,315.92		34,401.95		28,529.04		20,410.77	
Packing plant revolving fund		....		....		....		....	
Surplus		33,896.81		16,390.60		26,087.73		30,096.45	
Total		$510,876.74		....		....		....	
Less: Reserve for doubtful accounts	$ 43,372.25			....		....		....	
Experimental farm losses	1,365.51	44,737.76		....		....		....	
Total members' equity		$466,138.98	74.7	$411,107.61	99.3	$364,896.52	99.2	$350,026.41	90.4
Total Liabilities and Members' Equity		$624,005.24	100.0	$413,980.95	100.0	$367,745.69	100.0	$387,295.40	100.0
Number of notes overdue		107		131		53		142	
Amount of notes overdue secured by:									
Stock		$ 900.00		$ 900.00		$ 900.00		$ 900.00	
Mortgages and reserves		312,339.48		189,926.52		63,967.51		202,196.16	
Amount of notes unsecured		15,587.84		9,353.84		2,613.68		6,663.42	
Current ratio		1.86 :1		70.8 :1		81.9 :1		6.9 :1	

TABLE 18.—COMPARATIVE BALANCE SHEETS OF THE HASTINGS POTATO GROWERS' ASSOCIATION AS OF JUNE (continued).

Year	1927		1926		1925		1924		1923	
	ASSETS									
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Current Assets:										
Cash	$ 20,390.58		$146,785.68		$ 49,760.47		$ 25,769.93		$ 14,843.09	
Accounts receivable	17,167.98		210.00		10,878.70		1,431.73		854.81	
Notes receivable	45,539.24		6,271.74		58,422.84		55,803.21		10,851.62	
Less: Notes discounted	......		......		......		......		......	
Provision for bad debts	......		......		......		......		......	
Judgments	918.01		918.01		......		......		......	
Claims	......		......		913.97		1,886.20		84.95	
Other current assets	684.49		329.57		343.81		506.00		......	
Total current assets	$ 84,700.30	34.1	$154,515.00	73.5	$120,319.79	77.3	$ 85,397.07	82.1	$ 26,634.47	97.3
Deferred Assets:										
Advance on seed	......		......		......		......		......	
Supplies inventory	$ 3,281.49		$ 258.85		$ 460.30		$ 12,892.20		$ 158.56	
Total deferred assets	$ 3,281.49	1.3	$ 258.85	.1	$ 460.30	.3	$ 12,892.20	12.4	$ 158.56	.6
Fixed Assets:										
Office equipment	$ 4,771.86		$ 3,000.00		$ 2,615.60		$ 2,527.28		$ 578.52	
Automobile	600.00		500.00		450.80		507.15		......	
Revolving fund	2,047.50		2,730.00		2,730.00		2,717.50		......	
Buildings	38,799.39		......		......		......		......	
Farm equipment	......		......		......		......		......	
Packing plant	......		......		......		......		......	
Office site and other real estate	322.13		......		......		......		......	
Total fixed assets	$ 46,540.88	18.7	$ 6,230.00	3.0	$ 5,796.40	3.7	$ 5,751.93	5.5	$ 578.52	2.1
Other Assets:										
Reserve fund purchased	......		......		......		......		......	
Stocks	$ 74,100.00		$ 49,100.00		$ 29,100.00		......		......	
Bonds	40,000.00		......		......		......		......	
Cash in litigation	......		......		......		......		......	
Net value of life insurance	......		......		......		......		......	
Total other assets	$114,100.00	45.9	$ 49,100.00	23.4	$ 29,100.00	18.7	......		......	
Total Assets	$248,622.67	100.0	$210,103.85	100.0	$155,676.49	100.0	$104,041.20	100.0	$ 27,371.55	100.0

TABLE 18.—COMPARATIVE BALANCE SHEETS OF THE HASTINGS POTATO GROWERS' ASSOCIATION AS OF JUNE (concluded).

Year	1927		1926		1925		1924		1923	
	LIABILITIES AND MEMBERS' EQUITY									
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Current Liabilities:										
Accounts payable	$ 23.31		$ 21,708.24		....		$ 1,701.60		$ 150.00	
Notes payable	35,088.10		....		....		15,000.00		....	
Other current liabilities	....		1,543.40		$ 85.14		....		....	
Total current liabilities	$ 35,111.41	14.1	$ 23,251.64	11.1	$ 85.14	.1	$ 16,701.60	16.1	$ 150.00	.5
Members' Equity:										
Reserve for losses	....		....		$ 14,046.30		$ 9,051.46		....	
Sinking fund	$ 7,096.17		$ 629.75		....		....		....	
Growers' reserve for distribution	184,871.96		175,519.72		126,521.28		74,428.58		$ 22,453.11	
Building revolving fund	8,346.28		....		....		....		....	
Packing plant revolving fund	....		....		....		....		....	
Surplus	13,196.85		10,702.74		15,023.77		3,859.56		4,768.44	
Total	....		....		....		....		....	
Less: Reserve for doubtful accounts	....		....		....		....		....	
Experimental farm losses	....		....		....		....		....	
Total members' equity	$213,511.26	85.9	$186,852.21	88.9	$155,591.35	99.9	$ 87,339.60	83.9	$ 27,221.55	99.5
Total Liabilities and Members' Equity	$248,622.67	100.0	$210,103.85	100.0	$155,676.49	100.0	$104,041.20	100.0	$ 27,371.55	100.0
Number of notes overdue	52		17		44		....		14	
Amount of notes overdue secured by:										
Stock	$ 900.00		$ 900.00		$ 900.00		....		....	
Mortgages and reserves	44,499.07		1,000.00		30,459.39		....		$ 2,170.32	
Amount of notes unsecured	140.17		4,371.74		27,063.45		....		8,681.30	
Current ratio	2.4:1		6.6:1		1413.1:1		5.1:1		177.6:1	

TABLE 19.—STATUS OF THE BUILDING REVOLVING FUND, 1926-27 TO 1933-34, INCLUSIVE.

Season	Additions to Fund	Distribution of Fund				Balance in Fund End of Season
		Growers	Applied on Growers' Notes Charged Off	Sinking Fund	Adjustment	
1926-27	$ 8,346.28					$ 8,346.28
1927-28	12,064.49					20,410.77
1928-29	8,118.27					28,529.04
1929-30	5,872.91					34,401.95
1930-31	8,913.97					43,315.92
1931-32	3,379.78	$ 6,293.74				40,401.96
1932-33	5,915.11					46,317.07
1933-34	2,508.67	5,915.11*	$6,754.07	$1,859.38	$280.95	34,016.23
Total	$55,119.48	$12,208.85	$6,754.07	$1,859.38	$280.95	

* Made in June 1933 shortly before the books were closed for the 1932-33 season.

TABLE 20.—STATUS OF THE PACKING PLANT REVOLVING FUND, 1931-32, 1932-33, AND 1933-34.

Season	Additions to Fund	Distribution of Fund		Balance in Fund End of Season
		Applied on Growers' Notes Charged Off	Sinking Fund	
1931-32	$2,336.35			$2,336.35
1932-33	1,925.44			4,261.79
1933-34	4,592.88	$471.24	$128.01	8,255.42
Total	$8,854.67	$471.24	$128.01	

The members' equities in the Association, which are the various reserves, have already been discussed. It will be observed from the balance sheet that at no time has the members' equity in the Association been less than 73.8 percent of the assets. It has averaged for the 12 years 86.7 percent of the assets and was 97.2 percent at the close of the 1933-34 season.

HASTINGS AGRICULTURAL CREDIT CORPORATION

The Hastings Agricultural Credit Corporation is strictly a subsidiary of the Hastings Potato Growers' Association. The charter provides that all stock of the Hastings Agricultural Credit Corporation shall be held by the Hastings Potato Growers'

TABLE 21.—COMPARATIVE BALANCE SHEETS OF THE HASTINGS AGRICULTURAL CREDIT CORPORATION, AS OF JUNE.

Year	1934		1933		1932		1931		1930	
	ASSETS									
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Current Assets:										
Cash	$ 76,507.70		$ 3,725.43		$ 4,025.45		$ 5,644.00		$ 2,128.76	
Accounts Receivable	....		....		....		....		13.55	
Notes Receivable	151,808.99		122,119.93		105,829.83		94,690.87		108,423.09	
Premiums on Bonds	....		....		....		....		....	
Total Current Assets	$228,316.69	81.6	$125,845.36	45.6	$109,855.28	40.7	$100,334.87	38.5	$110,565.40	99.9
Office Equipment	....		$ 8.97	*	$ 30.52	*	$ 52.07	*	$ 73.62	.1
Bonds	$ 51,500.00	18.4	$150,210.94	54.4	$160,210.94	59.3	$160,210.94	61.5	....	
Total Assets	$279,816.69	100.0	$276,065.27	100.0	$270,096.74	100.0	$260,597.88	100.0	$110,639.02	100.0
	LIABILITIES									
Capital Stock and Surplus:										
Capital Stock	$250,000.00		$250,000.00		$250,000.00		$250,000.00		$100,000.00	
Surplus	29,816.69		26,065.27		20,096.74		10,597.88		10,639.02	
Total Liabilities	$279,816.69	100.0	$276,065.27	100.0	$270,096.74	100.0	$260,597.88	100.0	$110,639.02	100.0

* Less than one-tenth of one percent.

TABLE 21.—COMPARATIVE BALANCE SHEETS OF THE HASTINGS AGRICULTURAL CREDIT CORPORATION, AS OF JUNE (concluded).

Year	1929		1928		1927		1926		1925	
	ASSETS									
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Current Assets:										
Cash	$ 28,579.74		$ 1,504.54		$ 3,360.52		$ 38,358.91		$ 23,192.40	
Accounts Receivable			523.40							
Notes Receivable			23,089.97		35,088.10					
Premiums on Bonds									131.25	
Total Current Assets	$ 28,579.74	34.4	$ 25,117.91	31.4	$ 38,448.62	49.9	$ 38,358.91	75.4	$ 23,323.65	75.7
Office Equipment	$ 95.17	.1	$ 116.72	.2	$ 138.27	.2				
Bonds	$ 54,538.41	65.5	$ 54,538.41	68.4	$ 38,500.00	49.9	$ 12,500.00	24.6	7,500.00	24.3
Total Assets	$ 83.213.32	100.0	$ 79,773.04	100.0	$ 77,086.89	100.0	$ 50,858.91	100.0	$ 30,823.65	100.0
	LIABILITIES									
Capital Stock and Surplus:										
Capital Stock	$ 75,000.00		$ 75,000.00		$ 75,000.00		$ 50,000.00		$ 30,000.00	
Surplus	8,213.32		4,773.04		2,086.89		858.91		823.65	
Total Liabilities	$ 83,213.32	100.0	$ 79,773.04	100.0	$ 77,086.89	100.0	$ 50,858.91	100.0	$ 30,823.65	100.0

Association, except that each member of the board of directors of the Hastings Potato Growers' Association shall hold one share of a par value of $100.00. In the event a director of the Association is changed, the old director must offer his share of stock for sale at par to the Hastings Agricultural Credit Corporation, and the new director subscribes for one share of stock.

The purpose of the Hastings Agricultural Credit Corporation is to facilitate the borrowing of the parent organization from the Federal Intermediate Credit Bank of Columbia and other credit institutions. It will be observed from the balance sheet that at the end of each season there were no liabilities except capital stock and surplus (Table 21). The assets are primarily bonds (usually U. S. Government bonds) and notes receivable. During the 10-year period that the credit corporation has operated, an average of 45 percent of the assets has been in bonds, 43 percent in notes receivable, and 12 percent in cash, accounts receivable and office equipment.

TABLE 22.—SOURCE AND AMOUNT OF MONEY BORROWED BY HASTINGS POTATO GROWERS' ASSOCIATION FOR 12 YEARS OF OPERATION.

Season	National Bank No. 1	National Bank No. 2	National Bank No. 3	National Bank No. 4	State Bank No. 1	Federal Intermediate Credit Bank	Total
1922-23	$265,799				$ 8,700		$274,499
1923-24	608,841				25,000		633,841
1924-25	230,591				17,567	$184,661	432,819
1925-26	38,008				15,000	482,897	535,905
1926-27	193,312				12,500	562,500	768,312
1927-28	100,000	$ 30,000	$ 68,000		12,500	636,075	846,575
1928-29	80,000	65,600				399,950	545,550
1929-30		150,025		$200,000		500,400	850,425
1930-31		50,150		100,000		402,800	552,950
1931-32						278,950	278,950
1932-33						180,725	180,725
1933-34						192,200	192,200

The sources from which the Hastings Potato Growers' Association and the Hastings Agricultural Credit Corporation have borrowed are shown in Table 22. The greater part of this credit was obtained by the Hastings Agricultural Credit Corporation and in turn extended to the Hastings Potato Growers' Association. The usual procedure is for the grower to give to the Hastings Potato Growers' Association a note secured by a crop lien and real estate mortgage. The Hastings Potato Growers' Association assigns the growers' paper to the Hastings Agricultural

TABLE 23.—COMPARATIVE PROFIT AND LOSS STATEMENTS OF THE HASTINGS AGRICULTURAL CREDIT CORPORATION.

Season	1933-34	1932-33	1981-32	1930-31	1929-30	1928-29	1927-28	1926-27	1925-26	1924-25
Income:										
Interest and discounts	$15,366.99	$ 5,761.23	$14,847.42	$21,279.08	$27,205.63	$21,418.63	$29,099.50	$24,047.99	$17,910.16	$6,997.50
Interest on bonds	3,627.42	6,162.50	6,587.50	3,163.82	4,990.71	2,357.50	1,932.50	990.96	....	....
Total	$18,994.41	$11,923.73	$21,434.92	$24,442.90	$32,196.34	$23,776.13	$31,032.00	$25,038.95	$17,910.16	$6,997.50
Expense:										
Salaries	$ 2,380.96	$ 1,920.00	$ 3,800.00	$ 3,800.00	$ 3,800.00	$ 3,800.00	$ 3,800.00	$ 3,800.00	$ 3,000.00	....
Rent	1,500.00	240.00	240.00	240.00	240.00	240.00	240.00	240.00	240.00	....
Surety bond premiums and custodian fees	579.20	147.50	200.00	175.00	175.00	60.42	145.00	272.33	35.00	$ 35.00
Tax on capital stock	476.00	200.00	200.00	312.50	....	....	....	....	25.00	....
Auditing	50.00	62.50	70.00	72.00	71.45	61.60	....	....	....	....
Office supplies and postage	344.87	12.38	15.00	18.61	45.20	46.31	134.98	23.15	34.41	69.64
Depreciation	8.97	21.55	21.55	21.55	21.55	21.55	21.55	5.38	....	....
Interest paid	7,949.17	3,232.39	7,363.01	19,382.71	22,091.59	16,005.97	24,429.36	19,311.63	13,801.04	5,442.71
Miscellaneous	1,002.75	118.88	26.50	461.67	297.09	100.00	115.10	158.48	392.22	626.50
Total	$14,291.92	$ 5,955.20	$11,936.06	$24,484.04	$26,741.88	$20,335.85	$28,885.99	$23,810.97	$17,527.67	$6,173.85
Operating income	$ 4,702.49	$ 5,968.53	$ 9,498.86	–$41.14	$ 5,454.46	$ 3,440.28	$ 2,146.01	$ 1,227.98	$ 382.49	$ 823.65
Other income:										
Premium on sale of bonds	....	....	....	....	586.25	....	515.64	....	....	....
Income tax refund	....	....	....	....	....	....	182.98	....	....	....
Total	$ 4,702.49	$ 5,968.53	$ 9,498.86	–$41.14	$ 6,040.71	$ 3,440.28	$ 2,844.63	$ 1,227.98	$ 382.49	$ 823.65
Other expense:										
Loss on sale of bonds or premiums paid for bonds	$ 951.07	....	....	....	$ 3,615.01	....	$ 158.48	....	$ 212.50	....
Travel expense previous years	....	....	....	....	....	....	....	....	134.73	....
Net income	$ 3,751.42	$ 5,968.53	$ 9,498.86	–$41.14	$ 2,425.70	$ 3,440.28	$ 2,686.15	$ 1,227.98	$ 35.26	$ 823.65

Credit Corporation. The Hastings Agricultural Credit Corporation gives its note to the Intermediate Credit Bank, offering as security the growers' paper and in addition a margin of from $20,000.00 to $35,000.00 in Government bonds for each $100,000.00 borrowed.

TABLE 24.—CONSOLIDATED BALANCE SHEET OF THE HASTINGS POTATO GROWERS' ASSOCIATION AND THE HASTINGS AGRICULTURAL CREDIT CORPORATION AS OF JUNE 30, 1934.

ASSETS		
Current Assets:		
Cash	$149,968.01	
Accounts receivable	3,287.92	
Notes receivable	152,225.75	
Other current assets	16.30	
Total current assets		$305,497.98
Deferred Assets:		
Advance on seed	$ 7,401.62	
Supplies inventory	8,106.55	
Total deferred assets		15,508.17
Fixed Assets:		
Office equipment	$ 1,900.48	
Automobiles	1,263.84	
Office building	24,580.33	
Packing plant	35,625.63	
Office site and other real estate	22,275.34	
Total fixed assets		85,645.62
Other Assets:		
Banks	$ 60,909.75	
Cash in litigation	4,000.00	
Net value of life insurance	230.34	
Total other assets		65,140.09
Total Assets		$471,791.86
LIABILITIES AND MEMBERS' EQUITIES		
Current Liabilities:		
Accounts payable	$ 6,129.16	
Notes payable	6,256.60	
Total current liabilities		$ 12,385.76
Members' Equities:		
Sinking fund	$ 1,513.09	
Growers' reserve fund	379,066.50	
Building revolving fund	34,016.23	
Packing plant revolving fund	8,255.42	
Capital stock	900.00	
Surplus	35,654.86	
Total Members' equities		459,406.10
Total liabilities and Members' equities		$471,791.86

The Credit Corporation has only two sources of income, interest on bonds and interest and discounts on notes receivable. By far the most important item of expense is interest paid. Expenses exceeded receipts only one year in 10. A surplus of $29,816.69 has been accumulated during the 10 years of operation. The details of the income and expenses are shown in the profit and loss statements, Table 23.

For simplicity a consolidated balance sheet of the Hastings Potato Growers' Association and the Hastings Agricultural Credit Corporation has been prepared as of June, 1934 (Table 24). On this date, members' equities were 97.4 percent of the assets. Notes receivable, all of which were secured with reserves and/or real estate mortgages, were the largest asset, but cash was a close second. With all doubtful notes written off it is believed that the consolidated balance sheet presents a conservative picture of the business. At the close of the 1933-34 season there were 120 active and 34 inactive members. In addition 41 non-members had equity in the assets of the Association. The equity of individual active members ranged from $16.66 to $10,719.26 and averaged $2,423.17, while the average equity for all members and non-members amounted to $2,355.94.

SUMMARY

The Hastings Area is a highly specialized potato area.

The Hastings Potato Growers' Association was incorporated under the Florida Cooperative Act of 1909 in 1922. The organization was begun and completed without the aid of a promoter. At no time has the Association conducted a membership campaign.

The Hastings Potato Growers' Association was organized for the purpose of financing the production and marketing of the potato crop of farmers in the Hastings Area who wished to evade the expense of carrying poor credit risks that were necessarily passed on to them by the dealers of this area.

The Hastings Potato Growers' Association is a non-capital stock corporation controlled on the one-member one-vote principle. The equity of the members is in proportion to the use made of the Association.

Official U. S. D. A. grades for potatoes have been used as a basis for grading. Government inspection was used 7 out of 12 years.

Daily pools are operated. Off-grade potatoes are not included in the pool.

Sales are made on an f. o. b. basis when possible. When the sales are not made on f. o. b. bases they are either consigned or sold on a price arrival basis.

In order to improve the pack and better meet the demands of customers, a packing plant was installed at the beginning of the 1931-32 season.

Brokerage expense amounted to approximately 56 percent of the total selling expense, Table 6.

A field department is maintained to assist the growers in their production problems and to keep the sales department informed as to daily and weekly supplies.

In order to keep the credit structure of the Association in a strong position, a revolving growers' reserve fund is maintained by making a reserve charge for each unit of supplies furnished. This charge ranged from 6.5 percent of the value of the supplies for the 1933-34 season to 10.6 percent for the 1931-32 season and averaged 8.1 percent for the 12 seasons (Table 17). The growers' reserve fund retain for cash advanced ranged from 4.5 percent of the cash advanced for the 1922-23 season to 11.2 percent for the 1932-33 season and averaged 5.9 percent for the 12 seasons (Table 10). A total of $225,824.60 has been returned to the members from the growers' reserve fund (Table 13).

Cash advanced and value of supplies furnished ranged from $73.16 per acre for the 1932-33 season to $160.39 for the 1926-27 season and averaged $126.33 for the 12 seasons (Table 11).

Losses occurring in growers' accounts have been written off through a sinking fund. The sinking fund is maintained largely by the net interest income and the net income from operations (Table 14).

The best credit risks were those members who planted 100 percent of their available potato land to potatoes. Members having 100 percent of their potato land planted to potatoes on the average owed the Association $129.10, while members having less than 50 percent of their available potato land planted to potatoes on the average owed the Association $2,232.10 (Table 16). Members out of debt to the Association had on the average more acres of potatoes than members in debt to the Association (Table 15).

Charges for selling potatoes averaged 5.2 percent of the sales. Charges for handling supplies averaged 2.2 percent of the value of the supplies. On the whole the expenses for the services rendered by the Association were kept within the charges made for these services (Table 17).

The balance sheet reveals that the Association was in a strong financial position at the end of each season (Table 18).

The Hastings Agricultural Credit Corporation, a subsidiary of the Hastings Potato Growers' Association, was formed for the purpose of facilitating the borrowing from the Federal Intermediate Credit Bank and other credit institutions.

APPENDIX A

BY-LAWS
OF THE
HASTINGS POTATO GROWERS' ASSOCIATION

AS AMENDED TO MARCH 21, 1934

ARTICLE I

Section 1. It shall be the purpose of the Hastings Potato Growers' Association to market the farm products of its members in such manner as to secure therefor at all times the utmost values that may be obtainable under prevailing general crop and market conditions.

Section 2. It shall also be the purpose of this Association to serve its members in procuring and furnishing seed, fertilizer, containers and such a sum of money per acre, to be used in their business of farming and growing Irish potatoes, in such manner and to such extent as its Board of Directors may from time to time determine to be safe and advantageous.

Section 3. It shall also be the purpose of this Association to promote the general interests of its members in connection with their business of farming, by undertaking for them such other and incidental activities as may, in the judgment of its Board of Directors, be practical and advantageous and in no way adverse to the fullest achievement of its main purpose as stated in Sections One (1) and Two (2) of this Article.

ARTICLE II

Section 1. Any bona-fide grower of Irish potatoes who will pay the regular membership fee and sign the regular membership agreement, signifying thereby his or her intent and purpose to be bound by these By-Laws, may become a member of this Association, when elected thereto by the Board of Directors, and shall be entitled to hold a membership certificate.

Section 2. All members shall be entitled equally to have their potatoes or other farm products marketed by the Association, and to enjoy the various incidental benefits of membership.

Section 3. The membership fee shall be fixed by the Board of Directors to meet the best interests of the Association.

Section 4. The term of membership in this Association shall extend through ten consecutive crop seasons, terminating the last day of the last fiscal year of such membership. Membership so terminating may be renewed as provided in Section 5, Article II of these By-Laws.

Section 5. Renewal of membership shall be made by application in writing to the Board of Directors of this Association. Such application shall be filed with the Secretary of this Association at least ten (10) days prior to the last day of the fiscal year of the Association, in which such membership expires. Such renewals shall become effective if and when they have been accepted and approved by the Board of Directors of the Association.

Section 6. The initial membership fee charged members of this Association shall cover any and all renewals of such membership, when the member so renewing does not at any time cease to be a member of this Association.

Section 7. Any member who shall fail to file his or her application for renewal of membership agreement as required by Section 5 of this Article, and who shall subsequently desire such renewal, shall pay the regular membership fee required of new applicants for membership.

ARTICLE III

Section 1. Any member who shall be permitted to withdraw voluntarily from this Association at the end of his or her ten year membership agreement, shall not forfeit his equity in the Reserve Fund, provided such member is not indebted to this Association at the time of his voluntary withdrawal, and such member shall be entitled to his portion of the Funds from the Reserve Fund at such time as such refunds are authorized to be made by the Board of Directors of this Association.

Section 2. No member shall be permitted to withdraw, who is indebted in any manner to, or on account of, this Association, or who shall have its property in his or her possession, until such indebtedness shall have been fully paid, or such property restored to this Association.

Provided, that any member who is indebted to this Association may appear in person before the Board of Directors, and offer a settlement of such indebtedness.

Should such settlement meet with the approval of the Board of Directors, and the Board of Directors deem that such settlement is for the best interests of the Association, then, and in that event, such member shall be permitted to withdraw.

ARTICLE IV

Section 1. It shall be the duty of all members of this Association, and they hereby agree, to sell and market all their Irish potatoes through the agency of, or by the agency of, or by the agency provided and directed by, this Association.

Section 2. In the event that any member of this Association does otherwise sell, market or consign any of his Irish potatoes, he shall pay immediately to the Treasurer of this Association the sum of One ($1.00) Dollar per barrel for each and every barrel of 165 pounds, or the equivalent thereof, so sold, marketed or consigned, as agreed liquidated damages, the amount so provided to be paid to be in addition to and exclusive of any rights or remedies which the Association may have against said member under and by virtue of the provisions of any crop lien, chattel or real estate mortgage which said member at any time prior thereto shall have given to the Association for the purpose of securing the advancement of any monies, goods, chattels, wares, merchandise or other things of value, to aid him in the business of planting or farming. In default of such payment the same may be recovered by this Association, as plaintiff, in an action brought by it in any court having jurisdiction of the matter, and in addition thereto the Association may apply any funds in its possession belonging to such grower or that may now or later be due by it to said grower, to the satisfaction of such agreed liquidated damages.

Section 3. Every member selling or shipping Irish potatoes through or by the means established or authorized by this Association, shall pay such an amount of money per sack, crate or barrel as may be found by the Board of Directors from time to time to be necessary to create such a revenue as will defray all expenses incurred in the conduct of the business of this Association.

Section 4. Should any member of this Association fall behind and owe this Association any money at the close of any season, he or she shall be required to give to this Association a new note covering such indebtedness secured by a lien on his or her following year's crop, and may be required to furnish such additional security as may be deemed necessary by the Board of Directors to protect the best interests of this Association.

Section 5. It shall be the duty of any member of this Association, who may at any time rent, lease, sell, convey or shall in any manner transfer his or her right to farm any of the lands owned by him or her at any time during the life of his or her contract of membership, to give written notice of such renting, leasing, selling, conveying, or transferring his or her right to farm said lands, to this Association, on or before the 10th day after such renting, leasing, selling, conveying, or transferring of his or her right to farm said lands has been consummated, and any member renting, leasing, selling, conveying, or in any manner transferring his or her right to farm said lands, who shall fail to give the notice herein required, shall be deemed to have breached his or her contract of membership.

Section 6. Should any member of this Association, at any time during his membership therein, sell, market or consign any Irish potatoes produced or grown by him, or which may be purchased by him or in which he may have or acquire any interest whatsoever, directly or indirectly, through an agent, corporation, trustee, tenant, relation by blood or marriage or any person or corporation other than this Association, his action in so doing shall be construed as a breach of the terms of the membership contract entered into by him with this Association, and the Board of Directors, by an affirmative vote of not less than six of the members of said Board, shall have the power to cancel the contract of such member at any time they shall see fit to do so, after he has breached his contract with the Association in the manner aforesaid.

ARTICLE V

Section 1. The Annual Meeting of the members of this Association shall be held at the office of the Association at Hastings, Florida, on the 30th day of June each and every year at two-thirty (2:30) o'clock p.m., provided, however, should this date fall on Sunday, the meeting shall be called for the day following.

Section 2. Special meetings of the members may be called by the President at any time, by mailing notice to each member, at least one week previous thereto, and upon publishing notice of said meeting, as required by the Laws of the State of Florida. One-fourth of the members shall constitute a quorum for transaction of business at such meeting.

Section 3. The President shall be required to call a Special Meeting on written petition of one-fifth of the membership.

Section 4. In the election of Directors or the transaction of any other business each member shall have one vote, and cumulative voting or voting by proxy shall not be allowed.

ARTICLE VI

Section 1. The management of this Association shall be vested in a Board of Directors consisting of nine members, all of whom shall be members of this Association.

Section 2. It shall be the duty of the Secretary of the Association to advise the members of the Association of the names of growers nominated by the Nominating Committee to be offered the members to be voted on for Directors.

Section 3. Directors shall be elected at the Annual Meeting of this Association as follows: Three directors to be elected to serve a term of three years each, three directors to be elected to serve a term of two years each and three directors to be elected to serve a term of one year each, and at each succeeding Annual Meeting there shall be elected three directors each to serve a term of three years, as provided in Section 3, Article VI of the By-Laws of this Association as amended June 25, 1923, or until their successors are duly elected and qualified.

Section 4. Should a vacancy occur on the Board of Directors from any cause, such vacancy shall be filled by the remaining members of the Board of Directors electing a member of this Association to serve during the unexpired term.

ARTICLE VII

Section 1. The Board of Directors shall at its first regular meeting after each Annual Meeting of the members of this Association, elect a President, and Vice-President, both of whom shall be directors, each to serve terms of one year. They shall also elect a Secretary and Treasurer, provided the office of Secretary and Treasurer may be held by one and the same person who shall not of necessity be a member of this Association.

Section 2. The Board of Directors may also elect, appoint and employ a General Manager, Sales Manager and such inspectors and other employees as they may deem necessary to the proper conduct of the business of this Association.

ARTICLE VIII

Section 1. The Board of Directors shall constitute the governing power of this Association in all matters of business, and have full and general supervision over its affairs; shall hold regular meetings in the office of the Association on the first Monday of each month at 8 o'clock p.m. Special meetings of the Board may be called by the President at any time.

Section 2. Five (5) members of the Board of Directors shall constitute a quorum for the transaction of business.

Section 3. The Board of Directors shall authorize and approve all contracts and expenditures, determine and fix the compensation of all officers and employees.

Section 4. The Board of Directors shall have the right to borrow and loan money, and to incur such indebtedness from time to time, pledging the credit of this Association, as they may deem necessary to promptly conduct the business of this Association.

Section 5. At the close of the shipping season in each year, it shall be the duty of the Board of Directors to employ an Auditor, who shall be a Certified Public Accountant, to audit the books of the Secretary and Treasurer, General Manager, and Sales Manager.

Section 6. The Board of Directors, by an affirmative vote of not less than six members of said Board, shall have the power to cancel contracts with members of the Association who, at the time of such cancellation, are in good standing and are not indebted to the Association in any amount, and growers whose contracts shall be cancelled by the Board of Directors under the provisions of this Article shall thereupon cease to be members of this Association and shall have the same status as voluntary withdrawal members.

ARTICLE IX

Section 1. The Board of Directors shall create and maintain an Operating Fund. This fund shall represent such selling cost per package, of the products of the members of this Association, and such other operating charges as may be fixed by the Board of Directors, and shall be retained by them in conformity with Section 3, Article IV, of these By-Laws.

Section 2. The Operating Fund shall be used for the purpose of defraying any and all legitimate expenses of the Association.

Section 3. At the end of each fiscal year the Board of Directors may transfer the surplus remaining in the Operating Fund, or such part thereof as they may deem advisable, to the Sinking Fund for the purposes specified in Section 2, Article XII, of these By-Laws.

ARTICLE X

Section 1. The Board of Directors shall create and maintain a Reserve Fund. This Fund shall represent the differences between the actual price paid and the price charged the grower for services, fertilizer, seed, barrels, and other supplies which may be purchased by the grower through the Association, and such amount shall be placed to the credit of the individual grower in the Reserve Fund, subject at all times to such rules and regulations as may be prescribed by the Board of Directors governing such Reserve Fund.

Section 2. The funds accumulated in the Reserve Fund shall not be available for use in defraying operating and other incidental expenses, but shall only be used to protect and stabilize the Association credit.

Section 3. The Board of Directors shall at its discretion have authority to cover such shortages as may exist in growers' accounts at the close of any season's business, out of the funds available in the Reserve Fund, provided that the grower whose account shows such shortage shall first give to the Association a legal promissory note for the full amount of such shortage, together with a crop lien on his or her following year's crop, as specified in Section 4, Article IV of these By-Laws, and upon the payment of such note or notes, the principal sum thereof shall revert back to the Reserve Fund.

Section 4. The Board of Directors shall have power to invest any or all of the Reserve Fund in such mortgages, promissory notes, capital stock of other corporations, bonds, personal or real property as may be deemed best by said Board of Directors.

Section 5. When the net equities of the grower members of this Association in the Reserve Fund herein provided to be created and maintained shall exceed in the aggregate the sum of Three Hundred Thousand ($300,000.00) Dollars, the Board of Directors of this Association, should they deem it to the best interests of the Association so to do, shall be authorized and empowered to refund, pro-rate and distribute the amount of said net equities in said Reserve Fund in excess of said sum of $300,000.00 or any portion thereof, among grower members of the Association, under a revolving system to be devised, approved and put into operation by a majority vote of said Board of Directors, such refund to be pro-rated among the growers participating in the order in which it has been accumulated, to-wit, by years from the beginning. Provided, however, that no grower whose equity in the Reserve Fund (based on his acreage regularly enrolled on the date the distribution of said Reserve Fund is directed to be made as aforesaid) shall not have attained a minimum of Seventy-five ($75.00) Dollars per acre, shall be entitled to receive any part or portion of said Reserve Fund.

Section 6. Any equity in the Reserve Fund shall not be transferred except upon approval of the Board of Directors of this Association, and in no event shall such transfer be made to any person other than a member of this Association. Provided, however, that nothing in this Article contained shall be construed as limiting or preventing the Board of Directors of this Association, by an affirmative vote of not less than three-fourths of the members of the Board, from entering into a contract or contracts to purchase and/or from purchasing from any member of this Association his net equity in the Reserve Fund, or to prevent said Board of Directors from transferring any and all such net equities in the Reserve Fund of the Association so purchased to the Sinking Fund of said Association.

Section 7. In the event the Grower is indebted to the Association, all refunds shall pass to the credit of such indebtedness until such indebtedness has been fully paid.

ARTICLE XI

Section 1. The Board of Directors shall create and maintain a Building Revolving Fund, which Fund shall be derived from a charge and deduction of not less than one cent (1c) or more than three cents (3c) per barrel or equal package of grower's products marketed by this Association, and the amounts so charged and deducted from the account of each individual grower shall be placed to the credit of such individual grower in the Building Revolving Fund at the close of each annual shipping season, subject to such rules and regulations as may be prescribed by the Board of Directors of the Association governing and regulating such Building Revolving Fund. Provided, that the amount to be charged and deducted per barrel shall be fixed and determined by the Board of Directors annually at the last regular meeting of the Board which shall be held prior to the Annual Meeting of the members of the Association.

Section 2. The Board of Directors shall use the monies accruing to the Building Revolving Fund for the purpose of defraying the original cost and cost of any additions to the site and buildings situated and covering Lot 1, Model Land Company Sub-division which lies North of the F. E. C. Railway, at Hastings, Florida, and known as the Association Home Office Properties.

Section 3. All net income from rentals or otherwise accruing from the Home Office Properties shall be placed in the Sinking Fund of this Association at the close of each fiscal year.

Section 4. Whenever the accumulations in the Building Revolving Fund shall represent an excess over and above the cost of the Association Home Office Properties, as specified in Section 2 of this Article, the Board of Directors shall refund such excess to the growers participating under the revolving system, such refund to be made by years from the beginning.

Section 5. Any equity in the Building Revolving Fund shall not be transferred, except upon the approval of the Board of Directors of this Association, and in no event shall such transfer be made to other than a member of this Association.

ARTICLE XII

Section 1. The Board of Directors shall create and maintain a Sinking Fund, which Fund shall consist of such amounts as shall from time to time be transferred to it from the operating surplus by the Board of Directors, and of such net equities in Reserve Funds as shall from time to time be purchased by the Association from any of the members thereof, and such accumulations of interest which may be collected by this Association from any source whatsoever.

Section 2. The Sinking Fund shall be used to cover such losses as may arise in the conduct of the business of this Association, and the payment of such interest on the Reserve Fund balances as may be authorized by the Board of Directors, which interest shall not at any time exceed the rate of two percent per annum; provided such interest shall be computed upon Reserve Fund balances at the end of the fiscal year prior to the year in which such interest payments are made.

Section 3. When the accumulated funds in the Sinking Fund exceed the amount necessary to cover the losses specified in Section 2 of this Article, such excess or surplus may be transferred by the Board of Directors to the Reserve Fund, pro-rating same to the individual members on a percentage basis.

ARTICLE XIII

Section 1. The President shall preside at all meetings of the Board of Directors and at all meetings of the members.

He shall sign all certificates of membership and all contracts or other instruments in writing which have first been authorized by the Board of Directors. He shall have the power to call the Board of Directors together in extra or special sessions whenever he deems it necessary, and shall have, subject to the advice and consent of the Board of Directors, the general superintendency of the affairs of this Association.

Section 2. The Vice-President shall perform all the duties of the President, hereinbefore set forth, in the absence of the President.

Section 3. The Secretary shall keep a record of the meetings of the members and of the Board of Directors, in a book suitable for that purpose. He shall fill out and countersign the certificates of membership issued and make the necessary entries of the same. He shall have the custody of the seal of this Association and all books and records. He shall, upon instruction of the President, issue calls for regular and special meetings and shall discharge such other duties appertaining to his office as may be, from time to time, prescribed by the Board of Directors.

Section 4. The Treasurer shall be the custodian of all funds of this Association, and shall deposit such funds in such banks, as may be designated by the Board of Directors. He shall be bonded in a reputable surety company, which company must be licensed to do business in the State of Florida, in an amount which shall be deemed for the best interests of this Association, said amount to be fixed by the Board of Directors.

ARTICLE XIV

Section 1. The General Manager shall, by and with the advice and consent of the Board of Directors, manage and direct the business affairs of this Association and he shall perform all duties as may, from time to time, be imposed upon him by the Board of Directors. He shall also supervise the pooling of prices as provided in Article XV of these By-Laws.

Section 2. The General Manager shall see to it that the members of this Association are at all times kept informed with the utmost possible promptness, of the prices received for their products.

ARTICLE XV

Section 1. In making payment to its members for all potatoes sold, this Association shall average the prices received, in such manner that the price paid to such member for his or her potatoes shall represent the approximate average price received for all goods of the same grade and having the same intrinsic value, and loaded on the same day, *Provided, however,* that the car in which his or her goods are placed is completed for shipment when manifest of that day is closed.

ARTICLE XVI

Section 1. To be deleted.

ARTICLE XVII

Section 1. The fiscal year of this Association is hereby fixed to terminate on the 30th day of June of each year.

ARTICLE XVIII

Section 1. The order of business in all meetings of the members and Board of Directors of this Association shall be as follows:

1. Calling to order by the President.
2. Reading the minutes of the previous meeting.
3. Reports of officers and committees.
4. Election of Directors or officers.
5. Special business.
6. General business.
7. Discussion for the good of the Association.
8. Adjournment.

ARTICLE XIX

Section 1. Any change or amendments to these By-Laws must be proposed at a meeting of the members prior to the one at which it is to be voted upon, and must receive a two-thirds vote of the members present and voting.

ARTICLE XX

Section 1. All laws or parts of laws heretofore adopted which conflict and are not consistent with these laws are hereby repealed.

APPENDIX B

HASTINGS POTATO GROWERS' ASSOCIATION

GROWER'S APPLICATION FOR MEMBERSHIP

TO THE HASTINGS POTATO GROWERS' ASSOCIATION:

The undersigned hereby certifies that he is a grower of potatoes for market, and that during the past season did grow the number of acres of potatoes set above his signature hereto and that his crop of potatoes will be shipped from..., Florida.

The undersigned now hereby makes application for membership in the Hastings Potato Growers' Association, and agrees that if accepted for membership, that he will abide by the By-Laws of the Association, as well as any other rules or regulations that are in force, or that hereafter may be made and put in force by the due authority of the Association.

The undersigned also agrees that when he shall have been accepted for membership by the Association, and when he shall have received notice of the same, either in person or by notice having been addressed to him at his address given below, and when the President and Secretary of the Association shall have affixed their signatures to the contract forming a part hereof, the applicant shall be deemed to have entered into a contract with the Association, and with each and every member of the Association in terms as follows:

MEMBERSHIP CONTRACT

This contract made between.., of the County of.., State of Florida, hereinafter known as the Grower, and the Hastings Potato Growers' Association, a non-profit corporation without capital stock, organized under the Laws of the State of Florida, hereinafter known as the Association; Witnesseth:

FIRST: THE GROWER AGREES, STIPULATES AND WARRANTS THAT ALL IRISH POTATOES SUITABLE FOR MARKETING, PRODUCED BY HIM, OR HER, OR WHICH MAY BE PURCHASED BY HIM, OR HER IN WHOLE OR IN PART, OR IN WHICH HE MAY HAVE OR ACQUIRE ANY INTEREST WHATSOEVER THEREIN, IN WHOLE OR IN PART, DIRECTLY OR INDIRECTLY, THROUGH AN AGENT, CORPORATION, TRUSTEE, TENANT, RELATION (BY BLOOD OR MARRIAGE), OR ANY OTHER INTEREST IN THE OWNERSHIP OF IRISH POTATOES, IN WHOLE OR IN PART, IN ST. JOHNS, PUTNAM, FLAGLER AND...................................COUNTIES FOR A PERIOD OF TEN YEARS FROM DATE HEREOF, EXCEPT AS THE SAME MAY BE TERMINATED AFTER THE FIRST YEAR, AS PROVIDED IN THE BY-LAWS, SHALL BE MARKETED BY AND THROUGH THE ASSOCIATION; AND THE GROWER FURTHER AGREES, STIPULATES AND WARRANTS, THAT HE WILL NOT BY SUBTERFUGE, DEVICE, UNDERSTANDING (ORAL OR WRITTEN), ARRANGEMENT OR IN ANY MANNER WHATSOEVER, EVADE THE PROVISIONS OF THIS CONTRACT, AND FOR THE VIOLATION OF THIS PROVISION, AS WELL AS ALL OTHER PROVISIONS OF THIS CONTRACT, THE GROWER AGREES TO BE SUBJECT TO THE PENALTIES PROVIDED BY THE RULES AND BY-LAWS OF THE ASSOCIATION.

SECOND: The Grower agrees to abide by such rules and regulations as shall be duly put in force by the authority of the Association covering the care and treatment of seed, methods of production and disease control, and methods of harvesting and handling, as well as all other regulations and rules connected with the production of potatoes that the Association may find necessary to put in force to insure the highest possible quality of its product.

THIRD: The Association agrees to sell the potatoes delivered under this contract, together with the potatoes of other growers delivered under similar contracts, at the best prices obtainable under the existing market conditions. From the net amount received from the sale of these potatoes, there shall be deducted such charges, fees or dues as the Association shall require for its operation. Such charges, fees or dues to be in the form of a fixed amount per package or car for each and every package or car handled during that season. The balance shall be credited to the Growers in accordance with a pooling plan hereinafter mentioned and defined.

FOURTH: The Association shall classify the potatoes delivered it under this and similar contracts in accordance with accepted market standards, and shall pool or mingle all potatoes of the same grade and classification, and the Grower agrees that the amount credited to him as aforesaid shall be a proportionate part of the net returns of the pool or pools of which his potatoes form a part. The number of pools and the time of opening and closing pools shall be determined by the By-Laws of the Association.

FIFTH: The Association may sell the potatoes delivered to it under this and similar contracts in such manner and under such terms as shall in the judgment of the directors best promote the interests of the Grower and shall employ as selling agent any person, firm or corporation which it may select, provided only that such person, firm or corporation shall not be permitted to speculate in potatoes.

SIXTH: THE GROWER WARRANTS THAT HE HAS NOT HERETOFORE CONTRACTED TO SELL, MARKET, CONSIGN OR DELIVER ANY OF HIS POTATOES TO ANY PERSON, FIRM OR CORPORATION.

SEVENTH: The Grower agrees not to place any lien or mortgage upon or sell any of his potato crop during the term of this contract, without the consent of the Association in writing first had and obtained, and further agrees that no such lien or mortgage shall release him from his obligation to sell his potatoes through the Association under the terms of this contract.

EIGHTH: The Grower agrees to give to the Association, each year for loans or advances made to the Grower by the Association, a statutory crop lien as provided by law secured by such collateral security as may be deemed in the judgment of the Board of Directors most advantageous in protecting the best interests of the Association on all Irish potatoes to be grown by the Grower with the aid of such loans or advances.

NINTH: The Grower agrees that the Association shall at all times control and designate the amount in acreage to be planted by said Grower in Irish potatoes, as provided by the By-Laws.

TENTH: The parties hereunto agree that the By-Laws of this Association, also any or other rules and regulations that are in force governing the Association or its members and such other rules and regulations that hereafter may be made and put in force by due authority of the Association and the Grower's application for membership shall be and are hereby mutually agreed to be and are a part of this contract as fully and completely as if set out in full herein.

ELEVENTH: The parties hereto agree that there are no oral or other conditions, promises, covenants, or inducements in addition to or at variance with any of the terms hereof, and that this contract represents the understanding of both parties fully and completely. This contract terminates June 30th, 19............

Accompanying above application is the sum of $..................................... If above application shall be accepted by the Association, said sum shall be credited on the Grower's membership dues, but if the application shall be denied, said sum shall be returned to the Grower forthwith. No fee required with application for renewal of membership.

Read, considered and signed at..., Florida,

this..............................day of.., A.D. 19............

....(SEAL)
Witness. Grower.

....
Witness. ....P. O. Address.

Above application accepted and Contract signed by Hastings Potato Growers' Association, this....................day of................................, A. D. 19........

HASTINGS POTATO GROWERS' ASSOCIATION,

By..
President.

ATTEST:

....
Secretary.

Bulletin 287 December, 1935

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UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
GAINESVILLE, FLORIDA
WILMON NEWELL, Director

ECONOMIC STUDY OF

ABSENTEE OWNERSHIP OF CITRUS PROPERTIES IN FLORIDA

By

H. W. HAWTHORNE, Agricultural Economist, United States
Department of Agriculture
and
J. E. TURLINGTON*, Professor of Agricultural Economics,
College of Agriculture, University of Florida

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*Deceased

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ABSENTEE OWNERSHIP OF CITRUS PROPERTIES IN FLORIDA

By H. W. Hawthorne and J. E. Turlington

INTRODUCTION

This is a partial report on an economic study of the citrus industry in Florida, conducted by the Bureau of Agricultural Economics, United States Department of Agriculture, in cooperation with the College of Agriculture, University of Florida. The report has particular reference to owners of citrus properties in Florida who reside outside of the state. Primarily, its object is to present data obtained from absentee owners themselves relative to costs, returns and general grove information, in order that an absentee owner may have data for comparisons of his own property with those of other absentee owners, and that contemplating purchasers may have information for their guidance.

To carry out this objective, questionnaires[1] were mailed to more than 1,000 out-of-state owners of citrus properties in the summer of 1930. The questionnaire asked for data relative to costs of operating groves and receipts therefrom for the six seasons 1924-25 to 1929-30, inclusive; costs of developing groves; date of purchase of property; age of trees at the time of purchase; plantings made since purchasing; terms of payment for purchases; method of selling fruit; who determines the method; with whom the selling agency settles; such general information as occupation, trade, or profession of owner; whether or not he visits his property; and if so, the frequency and the extent of his visits. In several instances remarks were offered by those replying to the questionnaire, either as to the Florida citrus industry in general, or to their own properties in particular.

In response to the questionnaire, 477 absentee owners replied, giving all or a portion of the data and information requested. An appreciable number of the absentee owners in 1930 had bought their properties within the previous six years, and of course had data only for the years they had owned the property. Some, even though they had owned properties during the previous six years, had available records for only some of the years—those for the other years having been lost or destroyed. The replies from several of the owners were complete in all respects. Most of the replies indicated that a high degree of effort and care had been exercised on the part of absentee owners to report accurate data. Only a few gave "rounded off" or estimated figures. The approximate locations of the properties of absentee owners included in this report are shown in Fig. 1. Wide variations existed in the replies to each question. The tables are presented as fair approximations of the combined experiences of the persons reporting without attempt at finality of analysis. The distributions with respect to location, size of groves, age of trees, time and management factors are wide enough to cover all but exceptional cases.

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[1] See copy of questionnaire, pages 30-32.

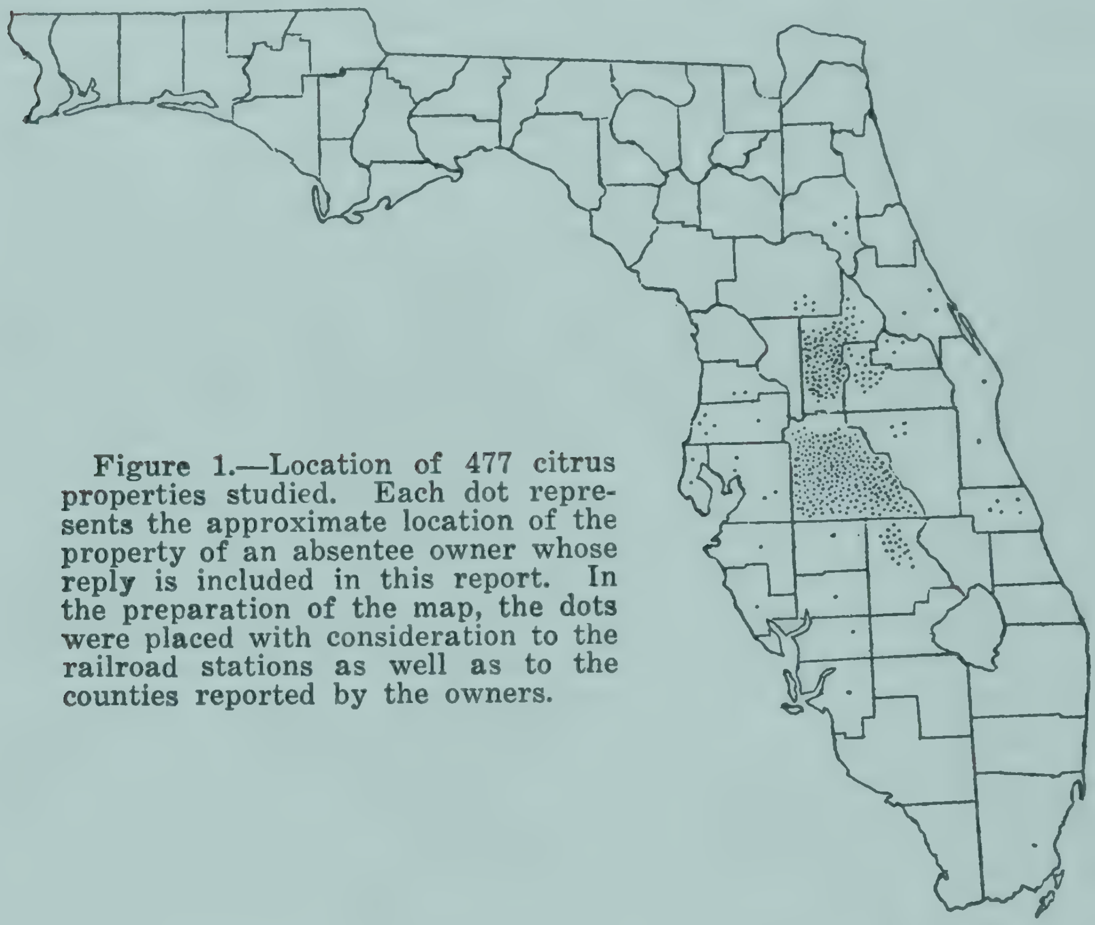

Figure 1.—Location of 477 citrus properties studied. Each dot represents the approximate location of the property of an absentee owner whose reply is included in this report. In the preparation of the map, the dots were placed with consideration to the railroad stations as well as to the counties reported by the owners.

The total acreage of the 477 properties upon which this report is based was over 8,000 acres, less than one-half of which had been planted to citrus when purchased by the present owner, but with approximately three-fourths in citrus by 1930. More specifically, the total acreage of properties of the 463 absentee owners who reported definitely on this point amounted to 8,605.9 acres, with 3,975.6 acres in citrus at time of purchase, and 6,501.1 acres by 1930. Of the 477 owners, 185 reported all of the acreage in citrus at time of purchase, 114 reported part in citrus, and 172 reported none had been planted to citrus when purchased. Six did not report on this question.

Of the acreage reported in 1929 as to kinds of fruit, 52 percent was in orange trees, 40 percent in grapefruit trees and 8 percent in tangerine trees. Several groves had orange trees only and several grapefruit only; but more often there were both orange and grapefruit trees in the same grove, and less frequently tangerine trees were included.

METHODS OF CARING FOR GROVES

Absentee owners seldom own equipment or tools to care for their groves, but employ a caretaker who has equipment for this purpose. The caretaker may be the owner of a grove in the community who has found it advantageous to care for one or more groves in addition to his own; or he may represent an individual, partnership, or corporation, whose business it is to care for other peoples' groves. There are several caretakers in the state each caring for 2,000 acres or more of grove, as well as a large number caring for less acreages. In a number of instances the caretaking business has been an outgrowth of the development of groves for sale where it was necessary to provide for the care of groves which had been sold, as well as for unsold groves.

Caretakers in addition to caring for groves owned by people who reside outside the State of Florida, also care for a large number of those owned by people who reside within the state, but who have practically no grove equipment, work stock, or other form of power. Some of these owners who live within the state and who employ caretakers reside at the grove, but a larger number of them live in nearby towns.

The methods of charging for the care of groves are far from standardized and vary greatly from a flat rate per acre, including all materials, power, supervision and labor, to charges by the day, acre, or tree for each operation, the owner furnishing or paying for all fertilizer and other materials. In some instances the grove owner purchases the fertilizer and other materials or a part of them, but perhaps more often the caretaker makes the purchases for the absentee owner.

METHODS OF HARVESTING, PACKING AND MARKETING FRUIT

The operations of harvesting, packing and marketing citrus in Florida usually are performed by a packing and marketing organization with whom the producer contracts. This is true whether the owner be a resident or an absentee. Less frequently sales are made of the fruit on the tree. In a few instances the producer picks, packs and markets his own fruit.

Almost one-half of the absentee owners reported that they themselves determine the harvesting and marketing agency through which their fruit is sold and almost another one-half reported that the caretaker determines the agency. Only 5 percent of the total number reported that they and the caretaker together determine the agency through which the fruit is sold.

Based upon the replies of 417 absentee owners, the selling agency settles directly with the owner in about 70 percent of the instances; and through the caretakers in the other 30 percent.

SIZE OF PROPERTIES AND AGE OF TREES

Properties ranged in size from less than one acre to over 200 acres, the more usual sizes were around 5 acres, 10 acres, and 20 acres, with those around 10 acres predominant. Frequently all of the land was in grove, which was especially true for those properties of around 10 acres or less. Occasionally less than one-half of the land was in grove, but this usually occurred on the properties of larger acreages.

The number of absentee owners whose acreage of property fell within the specified acreage groups in 1929 is shown in Table 1.

TABLE 1.—SIZE OF PROPERTIES OF 466 ABSENTEE OWNERS, 1929[1].

Size groups	Number of groves
Less than 3 acres	29
3 to 7 acres	90
8 to 12 acres	225
13 to 17 acres	22
18 to 22 acres	53
23 to 27 acres	8
28 to 32 acres	12
33 to 37 acres	4
38 to 42 acres	8
43 to 47 acres	3
48 to 52 acres	3
Over 52[2] acres	9

[1] The acreage of 11 properties was not reported.

[2] Includes 4 properties of over 100 acres, 2 of which were over 200 acres.

The age of trees ranged from those just planted in 1929 to over 30 years, and are fairly evenly distributed among the different ages from the sixth year up to and including the fifteenth year, when the number of groves of older trees dropped off rapidly. Usually the trees of a given grove were of a given age, except for replants, but there was an appreciable number of groves with trees of various ages. In a few instances the ages of trees were not reported. The number of absentee owners whose groves fell within the several age groups in 1929 is given in Table 2.

TABLE 2.—AGE OF TREES IN 1929[1].

Age of trees	Number of groves
First year (planted in 1929)	2
Second year	4
Third year	4
Fourth year	5
Fifth year	9
Sixth year	15
Seventh year	30
Eighth year	23
Ninth year	50
Tenth year	29
Eleventh year	18
Twelfth year	24
Thirteenth year	28
Fourteenth year	23
Fifteenth year	22
Sixteenth year	12
Seventeenth year	6
Eighteenth year	7
Nineteenth year	3
Twentieth year	5
Over twentieth year	24
Mixed ages	85
Unknown ages	38

[1] The age of trees was not reported for 11 properties.

The approximate situation as to the acreage and age of orange, tangerine and grapefruit trees in the United States and in some of the citrus producing States in November 1934 is summarized from the Agricultural Outlook for 1935, Miscellaneous Publication No. 215, United States Department of Agriculture, as follows:

In the country as a whole, there were about 539,000 acres of orange and tangerine groves. About 88 percent of the trees were nominally of bearing age. Two-fifths of the bearing acreage was less than 15 years old. Of the total acreage about 49 percent was in Florida, 44 percent in California and the remaining 7 percent was in Texas, Arizona, Alabama, Mississippi and Louisiana.

In Florida, early oranges made up about one-half of the acreage, with 15 percent not of bearing age. Late oranges made up about 40 percent of the acreage, with 13 percent not of bearing age, and the remaining 10 percent of the acreage was tangerines with 3 percent under bearing age. About three-fifths of the bearing acreage of oranges and tangerines in Florida was less than 15 years old.

There were about 215,000 acres of grapefruit trees in the United States in 1934, distributed as follows: Florida, 43 percent; Texas, 42 percent, the remaining 15 percent being located in California and Arizona.

In Florida, approximately 10 percent of its 93,000 acres of grapefruit was not of bearing age, and 55 percent of the bearing acreage was less than 15 years old.

CASH COSTS AND CASH RECEIPTS

Costs under this heading are to be interpreted as including such costs as labor up to the time of picking, fertilizer, spray materials and taxes. They do not include interest on investment and depreciation of groves, since the investment was not asked for in this questionnaire.[1] Receipts are net after deducting picking, hauling, packing, selling, and transportation charges.

BY SEASONS

The average seasonal costs and receipts for all groves in the sixth year and up reporting these items are shown in Table 3. The 6-year average receipts per grove, averaging 13.1 acres of citrus, exceeded the costs by $30.67, or $2.50 per acre of citrus. For the four seasons 1924-25, 1925-26, 1926-27 and 1929-30, receipts about equaled costs; for the season 1928-29, receipts were less than costs; and for the season 1927-28, receipts exceeded costs by a comfortable margin. The receipts from approximately one-fourth of the groves equaled or exceeded the costs in the poorest season, 1928-29. In the best season 1927-28, receipts exceeded the cost in about one-half of the groves.

In Table 4 data are shown corresponding to those in Table 3, for those groves whose receipts equaled or exceeded their costs. The groves included in Table 4 were but slightly larger and only slightly older than those included in Table 3. Their six-year average costs were $150.49 more per grove, or $4.36 per acre of citrus, while their receipts were $1,342.13 more per

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[1] Purchase prices of properties are shown in Table 17.

TABLE 3.—COSTS AND RECEIPTS PER GROVE FOR THE SEASONS 1924-25 TO 1929-30, INCLUSIVE.
(Groves in the sixth year and older)

Season	Groves	Acreage		Per Grove		Per Acre		Groves From Which Receipts Equaled or Exceeded Their Costs
		Total land	Grove in the sixth year and older	Costs (Without Interest)	Receipts	Costs (Without Interest)	Receipts	
Year	Number	Acres	Acres	Dollars	Dollars	Dollars	Dollars	Number
1924-25	70	17.2	12.8	1210.98	1198.00	94.61	93.59	29
1925-26	113	17.0	13.3	1175.06	1110.18	88.35	83.47	40
1926-27	154	16.7	13.3	1188.29	1202.05	89.34	90.38	58
1927-28	195	16.2	12.7	1246.62	1671.26	98.16	131.60	95
1928-29	256	16.2	13.1	1276.84	1053.00	97.47	80.38	71
1929-30	305	16.7	13.5	1225.79	1273.15	90.80	94.31	98
Average of six seasons		16.7	13.1	1220.60	1251.27	93.12	95.62	391

TABLE 4.—COSTS AND RECEIPTS PER GROVE FOR THE SEASONS 1924-25 TO 1929-30, FOR THOSE GROVES WHOSE RECEIPTS EQUALED OR EXCEEDED THEIR COSTS.
(Groves in the sixth year and older)

Season	Groves	Acreage		Per Grove		Per Acre	
		Total land	Grove in the sixth year and older	Costs (Without Interest)	Receipts	Costs (Without Interest)	Receipts
Year	Number	Acres	Acres	Dollars	Dollars	Dollars	Dollars
1924-25	29	18.6	14.3	1054.03	2190.54	73.71	153.18
1925-26	40	18.9	15.5	1464.34	2456.21	94.47	158.46
1926-27	58	16.5	13.6	1311.11	2403.29	96.40	176.71
1927-28	95	15.6	13.3	1478.18	2975.08	111.14	223.69
1928-29	71	17.1	14.2	1529.06	2656.71	107.68	187.09
1929-30	98	15.2	13.7	1389.83	2878.57	101.45	210.11
Average of six seasons		17.0	14.1	1371.09	2593.40	97.48	184.87

grove, or $89.25 per acre of citrus, than the average of all groves reporting.

Wherein were these differences in costs and receipts? The question is partly answered in Tables 5, 6, 11, 14 and 16, in which certain comparisons have been made relative to age of trees, taxes, fertilizer, other costs, yields per acre and prices per box.

BY AGE OF TREES

The 6-year average costs and receipts by age of trees for all of the groves are shown in Table 5, and similar data for those groves whose receipts equaled or exceeded their costs are shown in Table 6.

On the average the receipts from groves from the sixth to the eleventh years of age did not meet the costs; but for those from the twelfth year up, receipts were more than costs. Receipts from groves in the sixth to the eighth years did not meet costs in any of the six seasons, while those from groves in the ninth to eleventh years met the costs in only one of the six seasons.

While the 6-year average receipts for all of the groves in the sixth to the eleventh years of age did not meet the costs, those in about 25 percent of the instances did meet, or exceed, the costs, and while the average receipts for all of the groves in the fourteenth year and older exceeded the costs, those in about 40 percent of the instances did not equal the costs. Although average yearly receipts per acre for all of the groves were only $2.50 more than costs, for the groups of younger groves there was some enhanced value each year, due to increased growth of trees. On the other hand, certain individual groves were so poorly located in respect to soil and frost protection, that there was no enhanced value due to age of trees even though they may have been well cared for.

Some absentee owners have been led to expect that groves may be depended upon to pay their way at ages earlier than the data from these reports over the six-year period, 1924-25 to 1929-30, will substantiate.

One owner says: "This grove has been a disappointment to me. When purchased (1921 with trees in the third year) I was told in four years it would pay for the fertilizer and other expense; in six years it would be a money maker."

A compilation of data representing all the groves in the fourth year and up for which costs and receipts were reported is made in Table 7. In some instances a grove is represented for each

TABLE 5.—AVERAGE COSTS AND RECEIPTS BY AGE OF TREES FOR THE SIX SEASONS 1924-25 TO 1929-30, INCLUSIVE.

Age of Trees (Years)	Acreage		Per Grove		Per Acre		Groves	
	Total land	Grove	Costs (Without Interest)	Receipts	Costs (Without Interest)	Receipts	Total	From Which Receipts Equaled or Exceeded Their Costs
	Acres	Acres	Dollars	Dollars	Dollars	Dollars	Number	Number
Sixth to eighth	15.1	12.3	804.48	407.64	65.61	32.77	314	40
Ninth to eleventh	17.6	13.2	1190.45	1096.82	91.30	83.74	290	110
Twelfth to fourteenth	15.7	11.3	1241.95	1301.06	109.86	119.53	192	93
Fifteenth to seventeenth	9.0	7.1	943.52	1680.12	127.06	219.67	66	34
Eighteenth and older	12.6	10.9	1881.42	4083.15	170.79	353.49	62	40
Mixed and unknown	22.9	19.3	2086.77	2235.56	109.46	116.83	169	74
Average of all ages	16.7	13.1	1220.60	1251.27	93.12	95.62	1093	391

TABLE 6.—AVERAGE COSTS AND RECEIPTS BY AGE OF TREES FOR THE SEASON 1924-25 TO 1929-30, FOR THOSE GROVES, WHOSE RECEIPTS EQUALED OR EXCEEDED THEIR COSTS.

Age of Trees (Years)	Acreage		Per Grove		Per Acre	
	Total land	Grove	Costs (Without Interest)	Receipts	Costs (Without Interest)	Receipts
	Acres	Acres	Dollars	Dollars	Dollars	Dollars
Sixth to eighth	15.0	12.3	806.81	1206.41	86.16	155.74
Ninth to eleventh	15.8	12.5	1081.38	2063.27	86.41	164.83
Twelfth to fourteenth	12.7	10.1	973.08	2018.74	93.67	200.23
Fifteenth to seventeenth	8.6	7.1	968.95	2259.50	124.13	290.33
Eighteenth and older	14.0	13.0	2348.95	6366.95	176.66	437.12
Mixed and unknown	23.8	21.9	2270.60	3687.32	101.90	166.94
Average of all ages	17.0	14.1	1371.09	2593.40	97.48	184.87

of the six seasons, in some instances for five of the six seasons, and so on until some groves are represented for only one season. In the table a given grove is counted as many times as it represents seasons.

TABLE 7.—RELATION OF AGE OF GROVE TO COSTS AND RECEIPTS.

Age of trees	Total groves	Groves on which receipts were equal to or greater than costs	Groves on which receipts were			Groves with no receipts
			67 to 99 percent of costs	34 to 66 percent of costs	1 to 33 percent of costs	
Years	Number	Number	Number	Number	Number	Number
Fourth	60	0	0	1	15	44
Fifth	77	2	2	5	26	42
Sixth	98	9	7	16	37	29
Seventh	111	17	10	20	48	16
Eighth	105	14	11	39	32	9
Ninth	108	30	10	25	36	7
Tenth	95	35	15	23	20	2
Eleventh	87	45	3	15	19	5
Twelfth	79	41	12	14	11	1
Thirteenth	64	30	10	13	9	2
Fourteenth	49	22	11	10	4	2
Fifteenth and older	128	74	17	22	10	5
Mixed and unknown	167	74	22	25	40	6
All ages	1228	393	130	228	307	170

In not a single instance out of 60 did groves in the fourth year pay their way; that is, their receipts did not equal their costs, while in 44 instances there were no receipts. In two instances out of 77, groves in the fifth year paid their way, while in 42 instances there were no receipts. In nine instances out of 98, groves in the sixth year paid their way, while in 29 instances there were no receipts. From the eleventh year up groves paid their way in just about one-half of the instances. Of the 407 instances from the eleventh year up, there were 212 in which groves paid their way—and receipts exceeded costs by comfortable margins in many instances. From the eleventh year up, there were 53 instances in which receipts ranged from 67 to 99 percent of costs; 74 instances in which receipts ranged from 34 to 66 percent of costs; 53 instances in which receipts ranged from 1 to 33 percent of costs; and 15 instances in which there were no receipts.

Some of the apparent reasons why certain groves returned little if any receipts in a given year are:

First:—Trees failed to set a crop of fruit, because of poor soil, neglect, starvation, cultural mistakes, a very heavy crop the preceding season, leaving the previous crop on the trees too long, or frost damage.

Second:—Even with a crop of fruit set, there sometimes were little if any receipts to the grower, because there was low market demand for the kind or variety of fruit at the time it was offered, and hence the fruit sold on a market that failed to pay harvesting and marketing costs; prices were so low that fruit—especially of poor quality—was not harvested; the fruit was destroyed by cold, storms or fire.

Seldom did a grove in the sixth year or older fail to return any receipts two years in succession. Of the groves that had reached the fifteenth year of age or older by 1929, there was not a single instance in which a given grove failed to return any receipts two years in succession. There were 14 groves included which had reached the fifteenth year or older by 1929, and for which costs and receipts were reported each of the six seasons. For the entire six-season period receipts were greater than costs for 10 of these groves, and less than costs for the other four, but in no instance more than 26 percent less.

TAXES

Taxes, amounting to $6.71 per acre of property, or $8.76 per acre of citrus, on the average represented approximately 10 percent of the costs in Table 3, but varied widely from grove to grove, and, in many instances, from year to year for the same grove.

A summary of the average amount of taxes by years for all the properties reporting this item is made in Table 8.

TABLE 8.—AMOUNT OF TAXES PER ACRE BY YEARS.

Year	Groves	Acreage		Taxes			
					Per Acre		
		Total land	In Grove	Total	Total land	In Grove	Usual range
	Number	Acres	Acres	Dollars	Dollars	Dollars	Dollars
1924	73	1193.5	798.6	6,577.39	5.51	8.24	1.00 to 7.00
1925	112	2038.	1516.35	12,047.98	5.91	7.94	1.00 to 10.00
1926	151	2475.	1911.85	16,977.61	6.86	8.88	1.00 to 10.00
1927	195	3123.	2414.1	22,133.48	7.09	9.17	1.00 to 10.00
1928	248	4133.63	3300.72	28,838.64	6.98	8.75	1.00 to 11.00
1929	282	4577.6	3780.58	36,162.64	7.90	8.56	1.00 to 11.00
Six-year average		2923.5	2287.0	20.461.79	6.71	8.76	1.00 to 11.00

The amount of taxes increased with the age of trees as shown in Table 9.

TABLE 9.—AMOUNT OF TAXES PER ACRE BY AGE OF TREES, SIX-YEAR AVERAGE, 1924 TO 1929, INCLUSIVE.

Age of trees (Years)	Groves	Acreage		Taxes per acre		
		Total land	In Grove	Total land	In Grove	Usual range
	Number	Acres	Acres	Dollars	Dollars	Dollars
Sixth to eighth	306	4780.94	3811.56	3.57	4.48	Less than 1.00 to 8.00
Ninth to eleventh	274	4719.75	3596.2	6.50	8.53	1.00 to 11.00
Twelfth to fourteenth	173	2693.33	1937.55	8.24	11.45	5.00 to 11.00
Fifteenth to seventeenth	55	530.33	423.68	13.21	16.54	5.00 to 50.00
Eighteenth and older	80	1005.5	654.5	15.07	23.15	5.00 to 50.00
Mixed and unknown	173	3810.88	3298.71	8.05	9.30	1.00 to 15.00
All ages		2923.5	2287.0	6.71	8.76	

TABLE 10.—FERTILIZER COSTS PER ACRE BY AGE OF TREES AND BY SEASONS.

Age of trees	Fertilizer costs per acre						
	1924-25	1925-26	1926-27	1927-28	1928-29	1929-30	Average of the six seasons
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Sixth to eighth	22.04	22.54	22.33	23.23	23.82	23.66	22.94
Ninth to eleventh	40.91	35.21	35.49	32.61	42.12	30.16	36.08
Twelfth to fourteenth	53.12	61.69	54.44	48.62	47.36	38.50	50.62
Fifteenth to seventeenth	43.84	43.79	75.13	57.27	65.04	59.56	57.44
Eighteenth and older	54.32	86.93	82.58	77.12	61.22	58.69	70.14
Mixed and unknown	39.66	37.08	37.13	38.23	41.81	34.26	38.03
All ages	34.14	37.53	36.12	36.98	39.23	35.81	36.64
Number of Groves	59	89	127	157	200	245	

The six-year average ranged from $3.57 per acre of all property for trees in the sixth to the eighth years to $15.07 for trees in the eighteenth year and older. But when the total amount of taxes was divided by the number of acres in grove the range was from $4.48 to $23.15 for the respective age groups.

FERTILIZER

Fertilizer costs averaged $36.64 per acre of citrus for the groves in the sixth year and older, and represented approximately 40 percent of the total cash costs. The fertilizer costs varied from an average of $34.14 per acre for 59 groves in 1925 to $39.23 per acre for 200 groves in 1929 (Table 10).

The six-year average cost increased from approximately $23 per acre for the group of youngest groves (sixth to eighth years) to $70 for the group of groves in the eighteenth year and older.

The costs per acre also varied with groves of a given age—being more than twice as much for some groves as for others for the same years. When sorted on a basis of fertilizer costs per acre by age of trees, Table 11, costs other than fertilizer go up with increased fertilizer, but at a less rapid rate. Average prices of fruit were lower with increased yields and fertilizer costs, possibly due to a larger proportion of grapefruit.

While there are factors other than the amount of fertilizer used affecting the yields of citrus in Florida, yet there is a degree of relationship between the costs of fertilizer per acre and the yields of fruit. It is by no means always true that the higher fertilizer costs give the higher yields, nor that the lower fertilizer costs give the lower yields. Nor is it always true that the higher fertilizer costs and higher yields per acre give the higher net incomes. Sometimes the years, or groves, of higher yields and accompanied with lower prices give the lower net incomes both per acre and per grove. There are groves, or parts of groves, included in this study with soils and locations such that any amount of fertilizer will not give satisfactory returns. The indications are that with other favorable production conditions, as soil and drainage, it is probably better to err in a little too generous application of fertilizer, rather than in a scanty application.

OTHER COSTS

Cash costs other than taxes and fertilizer represented approximately 50 percent of total costs as the term is used in this report. These other costs were asked for under the headings,

TABLE 11.—RELATION OF FERTILIZER COSTS PER ACRE TO TOTAL COSTS AND RECEIPTS, AVERAGE OF SIX SEASONS, 1924-25 TO 1929-30.

Item	Sixth to eighth Years		Ninth to eleventh Years		Twelfth to fourteenth Years		Fifteenth Year and Older	
Fertilizer costs per acre	Below Average	Above Average	Below Average	Above Average	Below Average	Above Average	Below Average	Above Average
Number of groves	12	11	13	9	9	7	8	4
Acres: Total	15.6	12.4	16.2	13.3	10.8	13.6	7.8	11.3
Citrus	11.6	10.2	12.7	9.3	8.5	9.0	6.1	8.7
Costs per acre: Total Dollars	52.10	88.12	71.92	113.17	80.13	131.26	99.73	186.81
Taxes "	4.33	4.54	6.87	7.76	12.85	15.88	16.50	22.73
Fertilizer "	14.75	35.02	23.74	51.42	27.73	63.22	40.90	84.61
Other costs "	33.02	48.56	41.31	53.99	39.55	52.46	42.33	79.47
Receipts per acre: Dollars	30.33	35.53	82.80	100.11	117.26	171.12	167.80	272.52
Boxes sold per acre: Number	24	31	64	80	89	167	151	225
Price per box: Dollars	1.21	1.10	1.29	1.23	1.37	1.08	1.23	1.13

Spray and Other Materials, Tree Replacement, Picking Up Drops (1929 and 1930), and Cultivation, Labor, Caretaker, and All Other Costs.[1] The number of absentee owners reporting costs under these headings were fewer than the number who reported total costs. Frequently the total cost figures were available while the several items making up the total costs were not available. However, these items were stated in a sufficient number of replies to give a fairly reliable 6-year average. The figures are shown in Table 12 by age of trees.

TABLE 12.—COSTS PER ACRE OTHER THAN TAXES AND FERTILIZER BY AGE OF TREES, SIX-YEAR AVERAGE, SEASONS 1924-25 TO 1929-30.

Age of trees	Spray and other materials	Tree replacement	Cultivation, labor, caretaker and all other costs (excluding interest)	Total
Year	Dollars	Dollars	Dollars	Dollars
Sixth to eighth	5.73	2.13	30.37	38.23
Ninth to eleventh	6.66	1.22	38.74	46.62
Twelfth to fourteenth	7.47	1.19	40.37	49.03
Fifteenth to seventeenth	6.04	1.61	45.61	53.26
Eighteenth and older	12.79	2.46	62.53	77.78
Mixed and unknown	7.32	3.37	51.48	62.17
All ages	7.37	1.94	38.41	47.72

Federal quarantine regulations, which were applicable to what was known as the eradication area, required that dropped citrus be picked up and destroyed once every two weeks beginning September 1, 1929. Soon afterwards, the regulation was changed to once every week, and was in effect until November 15, 1930.

Hence the cost of picking up drops was inappreciable except for parts of the years 1929 and 1930 when the quarantine was in effect. Of the 477 absentee owners, 197 reported a separate cost for picking up drops in the season 1929-30. Many of the others reported that this cost was included in the 1929-30 total cost and 51 reported no cost for picking up drops—there being no cost for non-bearing groves. The 197 owners who reported a separate cost for this item gave $7,861.15 as the cost for a total acreage of 2,518.25 acres of groves, or an average cost of $3.12 per acre.

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[1] See copy of questionnaire, pages 30-32

YIELD PER ACRE

The yield per acre, measured by the number of boxes of fruit sold, is shown in Table 13, by age of trees and by kinds of fruit, for the six seasons 1924-25 to 1929-30.

TABLE 13.—YIELDS PER ACRE (boxes sold) BY AGE OF TREES, SEASONS, AND KINDS OF FRUIT.

Kind of fruit and Age of Trees	Boxes sold per acre						
	1924-1925	1925-1926	1926-1927	1927-1928	1928-1929	1929-1930	Average of 6 seasons
Years	Number	Number	Number	Number	Number	Number	Number
Oranges							
Sixth to eighth	31	13	7	20	20	9	17
Ninth to eleventh	34	34	44	38	45	32	38
Twelfth to fourteenth	36*	90*	48	69	95	71	68
Fifteenth to seventeenth	64*	74*	60*	90*	151	75	86
Eighteenth and older	163*	189*	246	222	272	163	209
Mixed and unknown	50*	18*	26*	67	40	44	41
All ages	54	46	42	48	62	44	49
Grapefruit							
Sixth to eighth	67	29	46	50	52	29	46
Ninth to eleventh	117	88	106	102	91	80	97
Twelfth to fourteenth	315*	40*	148	152	139	162	159
Fifteenth to seventeenth	66*	81*	328*	213	246	195	188
Eighteenth and older	146*	116*	180	229	300	164	189
Mixed and unknown	205*	67*	77	102	133	101	114
All ages	102	64	97	112	122	114	102
Tangerines							
Sixth to eighth	40*	16*	7	9	8	10	15
Ninth to eleventh	5*	8*	38*	43*	41	16	25
Twelfth to fourteenth	0*	0*	6*	150*	62*	52*	45
Fifteenth to seventeenth	—	—	—	0*	0*	64*	21
Eighteenth and older	220*	189*	191*	101*	311*	244*	209
Mixed and unknown	—	—	11*	1*	24*	47*	21
All ages	94	56	33	16	45	34	46
All Fruit							
Sixth to eighth	44	18	22	24	32	15	26
Ninth to eleventh	81	63	74	68	67	52	67
Twelfth to fourteenth	166*	61*	104	129	132	121	119
Fifteenth to seventeenth	65*	80*	247*	187*	233	176	165
Eighteenth and older	163*	164*	214	217	275	146	196
Mixed and unknown	134*	63	68	67	73	69	79
All ages	77	54	68	75	88	75	73

*Fewer than five groves included in average.

For the season 1929-30, 162 absentee owners with groves in the sixth year and up reported the yield of oranges; 154 the yield of grapefruit; 55 the yield of tangerines; and 213 reported the yield of all fruit. The six-season average yield per season for oranges of all ages was 49 boxes per acre. Tangerines aver-

TABLE 14.—RELATION OF NUMBER OF BOXES OF FRUIT SOLD PER ACRE TO COSTS AND RECEIPTS, AVERAGE OF SIX SEASONS, 1924-25 TO 1929-30.

Item	Sixth to eighth Years		Ninth to eleventh Years		Twelfth to fourteenth Years		Fifteenth Year and Older	
Yield per acre (boxes sold)	Below Average	Above Average	Below Average	Above Average	Below Average	Above Average	Below Average	Above Average
Number of groves	14	8	13	9	9	7	8	4
Acres: Total	15.4	13.2	17.7	12.9	11.4	13.0	7.2	12.2
Citrus	12.5	9.5	12.6	10.8	8.4	9.2	5.7	9.5
Cost per acre: Total Dollars (Without Interest)	61.01	83.92	75.98	90.26	88.28	115.78	121.57	151.05
Taxes "	4.16	4.87	6.66	7.91	13.36	14.00	18.25	22.17
Fertilizer "	21.15	30.15	27.95	35.63	33.76	52.54	51.07	69.76
Other costs "	35.70	48.90	41.37	46.72	41.16	49.24	52.25	59.12
Receipts per acre: Dollars	13.49	60.11	41.78	154.57	90.61	204.24	123.48	308.55
Boxes sold per acre: Number	10	58	31	120	61	196	102	302
Price per box: Dollars	1.29	1.07	1.36	1.28	1.48	1.06	1.20	.99

aged slightly lower than oranges, and the yield of grapefruit was more than double that of oranges. Yields varied from season to season and with the age of trees. The seasonal variations in yields of all fruit were from 54 boxes per acre in 1925-26 to 88 boxes in 1928-29, with much wider seasonal variations for individual groves.

The relation of yields per acre to costs and receipts is indicated in Table 14. Both costs and receipts were higher for the groves with above average yields in any given age group than for those with yields below average. For those groves with below average yields, receipts were far below costs up to the twelfth year and scarcely exceeded costs even when the trees were in their twelfth year and up, but for the groves producing above average yields receipts were well above costs from the ninth year up. The six-season average receipts per season from groves in the sixth to eighth years lacked $47.52 per acre of meeting costs when the yield was below average, but only $23.81 when the yield was above average; receipts from groves in the ninth to eleventh years lacked $34.20 of meeting costs when the yield was below average, but exceeded costs by $64.31 when the yield was above average; receipts from groves in the twelfth to fourteenth years exceeded costs by only $2.33 when the yield was below average, but by $88.46 when the yield was above average; and when the groves were in the fifteenth year and up, receipts were only $1.91 per acre more than costs when the yield was below average, while they were $157.50 in excess of costs when the yield was above average.

The higher yielding groups produced three or more times as many boxes per acre as the lower yielding groups, but the costs were not more than 50 percent greater. On the other hand the higher yielding groups were accompanied by lower prices per box, possibly because of a larger proportion of grapefruit.

PRICE PER BOX

The price received per box of fruit is shown in Table 15 for the six seasons 1924-25 to 1929-30, by kinds of fruit. For the season 1929-30, 151 absentee owners reported the price they received for oranges; 145, the price for grapefruit; 45 the price for tangerines, and 204 reported the price received per box for all fruit.

The six-season average price received for tangerines was much the same as for oranges, but that for grapefruit was only about one-half as much. Price variations for all fruit from season to season were greater than the variations in yield per acre. For the season 1928-29 the average price per box for all fruit was $ .79, while that for 1927-28 was $1.84. Price as shown in Table 15 is net after deducting picking, hauling, packing and selling charges. Although the average season price for oranges and tangerines was usually much higher than that for grapefruit, the price received for grapefruit in 1928-29 was $ .80 as compared with $ .73 for oranges and $ .81 for tangerines.

TABLE 15.—PRICES RECEIVED PER BOX OF FRUIT BY SEASONS AND KIND OF FRUIT.

(Net after deducting harvesting, packing and marketing costs.)

Kind of fruit	Price per box						
	1924-25	1925-26	1926-27	1927-28	1928-29	1929-30	Average of 6 seasons
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Oranges	3.21	2.32	1.76	2.80	.73	1.58	2.07
Grapefruit	.65	1.10	1.01	1.54	.80	1.27	1.06
Tangerines	3.32	2.27	1.96	3.28	.81	1.59	2.20
All fruit	1.38	1.57	1.22	1.84	.79	1.39	1.36

The relation of prices received per box of fruit to costs and receipts is indicated in Table 16. Both costs and receipts per acre were higher for the groves with prices per box above the average in any given age group than for those with prices below the average. The six-season average receipts from groves in the sixth to eighth years lacked $43.75 of meeting costs when the price received per box was below the average, but only $31.13 when the price per box was above average; receipts from groves in the ninth to eleventh years lacked $22.80 of meeting costs when the price per box was below average, but receipts exceeded costs by $51.49 when the price per box was above average; receipts from groves in the twelfth to fourteenth years exceeded costs by only $10.48 when the price was below average, but by $71.86 when the price was above average; and receipts from groves in the fifteenth year and up exceeded costs by only $29.93 when the price per box was below average, but by $268.81 when the price was above average.

Many factors affect the price received per box, such as kind of fruit (oranges, grapefruit and tangerines), variety of fruit, time of marketing, quality of fruit, and marketing agencies. Except for kind of fruit, the data do not permit analysis of these

TABLE 16.— RELATION OF PRICE PER BOX TO COSTS AND RECEIPTS, AVERAGE OF SIX SEASONS, 1924-25 TO 1929-30.

Item	Sixth to eighth Year		Ninth to eleventh Year		Twelfth to fourteenth Year		Fifteenth Year and Older	
Price per box	Below Average	Above Average	Below Average	Above Average	Below Average	Above Average	Below Average	Above Average
Number of groves	15	8	13	9	9	7	9	3
Acres: Total	12.8	16.9	15.4	14.4	11.9	13.8	8.9	9.8
Citrus	10.0	12.6	11.6	11.1	8.3	9.2	6.8	7.9
Costs per acre: Total Dollars (Without interest)	60.98	81.23	81.60	87.37	91.80	96.09	126.96	168.39
Taxes "	4.36	4.19	7.22	7.30	12.22	14.91	18.72	21.98
Fertilizer "	22.28	26.84	30.00	34.39	39.54	38.62	56.19	69.36
Other costs "	34.34	50.20	44.38	45.68	40.04	42.56	52.05	77.05
Receipts per acre: Dollars	17.24	50.10	58.80	138.86	102.28	167.95	156.89	437.20
Boxes sold per acre: Number	25	30	67	74	139	86	177	243
Price per box: Dollars	.74	1.56	.90	1.86	.82	1.83	.90	1.90

factors. Oranges sold higher than grapefruit every season except that of 1928-29 when both were very low in price (Table 15).

PURCHASE PRICE OF PROPERTIES

Prices paid for grove properties were influenced by a number of factors, as time of purchase, age of trees, condition of trees, price of citrus, grove profits for years immediately preceding purchase, advertising, salesmanship, and such natural conditions as soil fertility and frost protection. The average prices paid for properties by groups of years and by ages of trees are shown in Table 17.

Of the 449 absentee owners who reported the date their properties were purchased, 17 reported purchases in two or more years. Each one of the remaining 432 made his purchase in a single year. The earliest date given was 1880 and the latest 1930.

Of the 426 absentee owners who reported on the ages of trees when the property was purchased, 138 reported that none of the land was in grove at the time and that the purchase price did not include setting. Several others reported that the land was not in grove at the time of purchase, but that the purchase price included the setting of trees, and again some reported that the land was not planted to grove, but that planting and care for the first five years were included in the purchase price. Thirty of the purchasers reported groves of mixed ages, and the other 258 reported the purchase price as for a grove of a given age—ranging from the first year to the forty-first year.

Data for the 349 purchases in which the purchase price, age of trees and date of purchase were each reported are shown in Table 17.

The many factors entering into the prices paid for citrus properties render it impossible to say that any group, or groups, of purchases were better bargains than the others. However, there are indications that many of the purchases of groves in the first to fourth years of age were at relatively high prices, unless the groves were especially well located. There is not sufficient evidence from the later production of groves purchased in the first to fourth years of age to justify the relatively higher prices paid for such groves than for those in the fifth to seventh years of age or older.

Many citrus growers in Florida consider that properties worth maintaining as groves, enhance in value with each additional year of age to about the fifteenth year, when maximum

TABLE 17.—PURCHASE PRICES OF PROPERTY PER ACRE BY PERIODS AND BY AGE OF TREES WHEN PURCHASED.

Age of trees	Period when Purchased						Average of all purchases	
	1918 and earlier		1919-1924		1925 and later			
	Purchases	Price per acre	Purchases	Price per acre	Purchases	Price per acre	Purchases	Price per acre
Years	Number	Dollars	Number	Dollars	Number	Dollars	Number	Dollars
Not planted	66	108.	51	182.	5	224.	122	143.
First year	11	485.	31	405.	8	837.	50	517.
Second to fourth	10	303.	34	537.	9	686.	53	524.
Fifth to seventh	4	516.	28	815.	25	608.	57	678.
Eighth to tenth	1	783.	7	643.	15	962.	23	866.
Eleventh to thirteenth	—	—	3	656.	14	1118.	17	1072.
Fourteenth year and older	3	595.	9	2809.	15	1946.	27	2133.

selling value is probably reached. A fewer number prefer to place the minimum age for maximum selling value at about the twentieth rather than the fifteenth year. There is some evidence that grapefruit trees reach their maximum selling value at an earlier age than orange trees. There are indications that some of the purchases of groves in the fourteenth year or older by absentees were at prices much higher than those paid for younger groves (Table 17). However, average production and returns from such groves have apparently justified the higher prices paid for them. Not many absentees have purchased groves in the fourteenth year or older at such prices unless the groves were outstanding in production, or unless their potential values for development into building sites resulted in prices above their values as groves.

Of the purchases made in 1924 or earlier, fewer than 10 percent were of groves in the eighth year or older; while of those made in 1925 or later, almost 50 percent were of groves in the eighth year or older. Thus, there appears to be a tendency in recent years for absentee purchasers to buy developed, or partly developed, groves rather than properties not planted to grove or those which have been planted for only a few years. By purchasing older groves some of the development problems have already been answered as well as the probable frequency of frost damage. The experience and costs of trying to develop a grove on land too poor, subject to frequent frost damage, or otherwise unsuitable for citrus may be prevented. One absentee owner said, "All these groves (5 blocks of 10 acres each) were planted by me and my advice is, 'Never plant a grove, but buy a grove at least 5 or 6 years old, or still better, a bearing grove'."

Of the 369 purchasers who reported the amount of cash payment at the time of purchase of their properties, 182 paid all cash, and 9 others from 75 to 99 percent cash, while only about one-fifth of them paid less than 25 percent of the price at time of purchase. Thus, about one-half of the purchasers paid either all or a large proportion of the price in cash at the time of purchase. Of the others, 35 paid from 50 to 74 percent cash at time of purchase; 73 from 25 to 49 percent; 50 from 10 to 24 percent; and 20 paid less than 10 percent of the price in cash at the time of purchase.

The number of deferred installments varied widely and somewhat inversely with the amount of the installment, those who paid most frequently paying the least amount per installment.

Of the 162 purchasers reporting the number of deferred installments, 86 reported from 1 to 4; 22 reported from 5 to 9; 22 reported from 10 to 19; and 32 reported 20 or more. Of the last group, 11 purchasers reported 60 or more deferred payments.

Of the 136 purchasers who reported the frequency of the deferred installments, 36 reported that their payments were due monthly; 14, quarterly; 13, semi-annually; and 68, annually. One reported payments every 4 months and 4 reported more than one-year intervals in the payment of deferred installments.

The interest rate charged on deferred installments also varied. Of the 180 purchasers who reported this item, 78 reported 6 percent; 7 reported 7 percent; 69 reported 8 percent; and 2 reported 10 percent. One purchaser reported 6 and 8 percent, and one reported 8 and 10 percent. Twenty-two reported no interest rate, meaning that if interest was charged on deferred installments paid when due, it was included in the deferred installments.

COSTS OF PLANTINGS MADE SINCE PURCHASE OF PROPERTY

Data relative to costs of plantings made by absentee owners since purchasing their properties were asked for in the questionnaire. These were to include costs of each planting for each of the first four years.[1]

Reports covering the costs from the first to the fourth year inclusive were made for 64 plantings and included 568.4 acres. In addition to these, reports on costs for one, two or three of the first four years were made for several other plantings. In all, there were over 100 reports and they included over 1,000 acres for each year. The average of the operating costs per acre for the 64 plantings for the four years was much the same as for the larger number.

Data for the latter group and for the fifth year costs are shown in Table 18.

These plantings, including over 1,000 acres, represent approximately 40 percent of all the acreage of the 477 absentee owners which had been planted since purchase by the present owners. The average cost including land, clearing, trees, planting and care for the first five years, but not including interest, was $422.79 per acre, with a credit of $4.69 for fruit sold.

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[1] See copy of questionnaire, pages 30-32.

TABLE 18.—COST OF PLANTINGS MADE SINCE PURCHASING PROPERTY, INCLUDING THE FIFTH YEAR.

	Plantings	Acres	Costs per acre	Receipts per acre
	Number	Number	Dollars	Dollars
Land	122	1,972	143.00[1]	—
First year	120	1,013	101.56	—
Second year	109	1,032.5	38.78	—
Third year	107	1,054.6	41.92	—
Fourth year	111	1,080.7	47.29	.50[2]
Fifth year	74	807.5	50.24	4.19[3]
Total			422.79	4.69
Receipts			4.69	
Cost less receipts			418.10	

[1] Average price of all purchases of properties not planted. For average price of purchases, in different periods, see Table 17.

[2] Receipts from 85 of the 1080.7 acres.

[3] Receipts from 211 of the 807.5 acres.

Certain items entering into first-year costs were reported separately for some of the plantings. Most of these items were reported for only a few of the plantings but the figures appear to represent fairly dependable averages of costs for the given items. The figures are as follows:

Cost of clearing land was reported for 16 plantings, including 154.5 acres, at an average of $31.31 per acre.

Cost of plowing was reported for 3 plantings, including 50 acres, at an average of $5.41 per acre.

Cost of fencing was reported for 11 plantings, including 102.5 acres, at an average cost of $7.56 per acre.

Cost of trees (asked for separately in the questionnaire) was reported for 191 plantings, including 1,522.4 acres, at an average of $61.69 per acre.

Cost of setting trees was reported for 7 plantings, including 65 acres, at an average of $8.44 per acre.

Cost of cultivation and other labor was reported for 3 plantings, including 21 acres, at an average of $6.93 per acre.

Cost of fertilizer was reported for 6 plantings, including 61 acres, at an average of $11.68 per acre.

Taxes were reported for 3 plantings, including 40 acres, at an average of $2.20 per acre.

GENERAL INFORMATION

Evidently the number of absentee owners of citrus properties in Florida included in this report is but a small percentage of the total number. However, the general information which was reported on the questionnaires, both as to the groves and as to the owners themselves, is more or less representative of many other absentee owners. Some of these data are presented here in summary form.

ABSENTEE OWNERS LIVE IN MANY STATES

The absentee owners whose records form the basis for this report resided in 35 States of the United States, in the District of Columbia, in the Territory of Hawaii, in the Dominion of Canada and in Cuba.

The States and countries wherein they resided with the number of absentee owners in each are as follows:

RESIDENCE OF ABSENTEE OWNERS BY STATES

State	Number of absentee owners
Illinois	59
Ohio	56
Pennsylvania	49
New York	45
Indiana	26
Massachusetts	24
Michigan	20
New Jersey	17
Wisconsin	17
Minnesota	16
Georgia	12
Tennessee	12
Connecticut	11
Oklahoma	11
Iowa	10
Alabama	9
Missouri	9
South Carolina	8
Kentucky	6
Virginia	6
West Virginia	5
California	4
North Carolina	4
Kansas	3
Maryland	2
Mississippi	2
Nebraska	2
New Hampshire	2
North Dakota	2
Washington	2
Arkansas	1
Idaho	1
Rhode Island	1
South Dakota	1
Vermont	1
District of Columbia	4
Territory of Hawaii	1
Cuba	1
Dominion of Canada	8

OCCUPATIONS, TRADES AND PROFESSIONS OF ABSENTEE OWNERS

The occupations, trades and professions of absentee owners were many and varied. Of the owners reporting data, 10 were corporations, companies or partnerships, 391 were men and 74 were women. Over 100 occupations, trades, or professions were reported by 371 of these men and women. Fifteen others reported that they had no occupation, trade or profession and 29 others reported that they had retired. Among the occupations, trades, and professions these absentee owners more frequently classed themselves as teachers, housewives, farmers, merchants, manufacturers, salesmen; clerks, secretaries, accountants; architects, contractors, builders; engineers—civil, mechanical, electrical or chemical; ministers, missionaries; doctors, nurses; lawyers, bankers, brokers, realtors; superintendents, machinists, printers; and railroad engineers, conductors, agents, firemen. Among those less frequently given were general managers, executives, capitalists, editors; artists, musicians, photographers; electricians, engravers, metal workers, pattern makers, riggers; plumbers, carpenters, painters, weavers, barbers, bakers, and blacksmiths.

MANY ABSENTEE OWNERS VISIT THEIR GROVES OCCASIONALLY

Of the absentee owners whose replies form the basis of this report, 382 have visited their groves, 50 have never visited their groves, and 42 did not reply to this question. Of the 382 who have visited their groves, 298 visit every year, leaving only 84 who visit their groves less frequently than once per year. Of the 298 who visited their groves every year, 182 made only one visit annually, while the other 116 made more than one visit; 38 reported two visits per year; 20, three visits; 12, four visits; 11, five visits; and the remaining 35 made more than five visits per year.

Approximately one-fourth of those who visited their groves were there for only a day or less at a time. About one-fifth of them spent a few days to a week at their groves; another one-fifth from 8 days to a month; and another one-fifth spent more than one month annually at the groves. Less than one in ten were at their groves for three or more months per year. About two-thirds of those who visited their groves reported that they did so for the purpose of inspection. Less than one-sixth of them reported for pleasure, vacation, visit, rest, or spending the winter; and almost another one-sixth, for business or work. Occasional purposes reported were for health, comfort, climate, and for satisfying curiosity.

SOME ABSENTEE OWNERS CHANGE CARETAKERS

Of the 422 absentee owners who reported on the number of caretakers they have had since purchasing their groves, 224, or slightly more than one-half, reported but one caretaker; 112, or more than one-fourth, reported having had two caretakers, and 44, or more than one-tenth, reported having had three caretakers. The others each reported four or more caretakers.

THE QUESTIONNAIRE

A copy of the original questionnaire appears on pages 30-32. Absentee owners receiving this report, but who did not receive the original questionnaire, may use this form for recording data for their own properties, and mail it either to the Division of Farm Management and Costs, Bureau of Agricultural Economics, Department of Agriculture, Washington, D. C., or to the Department of Agricultural Economics, University of Florida, Gainesville, Florida. Any reports received in this manner may be used in later tabulations.

ABSENTEE OWNERSHIP OF CITRUS PROPERTIES IN FLORIDA

Extent, Methods of Handling, and Profitableness

Owner's name.............................. Address.............................. Profession....................

Location of grove: County................................ Railway Station............................

Acres in grove at time of purchase.................... Acres not in grove....................

Date of purchase......................... Approximate age of trees at that time............

Total price of land and grove............... Cash paid at time of purchase............

Number of installments................ Frequency.................... Interest rate on the deferred payments.....................................

Approximate number of annual visits to grove.................... Average time at grove per visit.................... Purpose of visit............................ Number of boxes of fruit taken or shipped to your family and friends annually:

Oranges......................... Tangerines......................... Grapefruit..........................

Usual method of sales: On the tree....................Through Exchange or other cooperative............................ Through other marketing agency............................

Who determines method of sales, you or caretaker.................................. With whom does selling agency or purchaser settle, you or caretaker?......................

Name of present caretaker.. Address..............................

How many different caretakers have you had since purchasing the grove?
....

What was your cost for picking up drops for 1929-30?..

Planting Since Making Purchase

	1st Planting	2nd Planting	3rd Planting	4th Planting
Year planted				
Acres planted				
Cost of trees				
Kind of trees				

All other Costs for Each Planting, including Setting, Labor, Fertilizer, etc.

First year				
Second year				
Third year				
Fourth year				

Present acreage in: Oranges.................Tangerines.................Grapefruit.................

Yearly Cost of Upkeep and Maintenance for a Number of Years: Include Total Acres Now in Grove.

Season	Taxes	Fertilizer	Spray and Other Materials	Picking up Drops	Tree Replacement	Cultivation, Labor, Care-taker and All Other Costs	Total Cost Maintenance
29-30							
28-29							
27-28							
26-27							
25-26							
24-25							

Boxes Sold and Income Received by You After Deducting Picking, Packing and Selling Charges

Season	Oranges		Tangerines		Grapefruit		Total Receipts	Name of Sales Agency or Purchaser
	Boxes	Receipts	Boxes	Receipts	Boxes	Receipts		
29-30	....	....	....	....	....	....	....	....
28-29	....	....	....	....	....	....	....	....
27-28	....	....	....	....	....	....	....	....
26-27	....	....	....	....	....	....	....	....
25-26	....	....	....	....	....	....	....	....
24-25	....	....	....	....	....	....	....	....

Indicate here if you desire a summary of our findings..............................

Remarks:..

....

....

Bulletin 291 February, 1936

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AGRICULTURAL EXPERIMENT STATION
GAINESVILLE, FLORIDA
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RELATIVE SUSCEPTIBILITY OF SOME ANNUAL ORNAMENTALS TO ROOT-KNOT

By C. C. GOFF

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RELATIVE SUSCEPTIBILITY OF SOME ANNUAL ORNAMENTALS TO ROOT-KNOT

By C. C. Goff

Root-knot is a very important factor in the growing of annual ornamentals, for both the commercial grower and for the person who grows a few flowers for the home. Generally the ground for the annual garden is a small plot used year after year, and it is in this type of plot that the root-knot nematodes become most abundant. In a small area of this sort it is comparatively easy to treat the soil and reduce the infestation. The grower, however, may not be able to afford the cost of the materials for controlling the infestation, or may not care to go to the trouble of treating. In that case it is of interest to know what flowers can be grown on the land and be free of root-knot or little affected by it. Since little was known about the relative susceptibility to the root-knot nematode of the various annual ornamentals commonly grown in Florida, experiments were carried out to determine this.

EXPERIMENTAL PLANTINGS

Four plantings were made near Leesburg on Blanton fine sand. Two of these were made in the late fall and winter of 1932-33 and 1933-34, and two in the spring of 1933 and 1934. Most of the plants used were started in flats from which the young plants were set in the field. In the cases where the plants were not of the type that could be transplanted easily, the seed was planted directly in the experimental plot.

For the most part the plants tested were annuals and perennials commonly grown as annuals in Florida gardens.

Planting No. 1.—The plants and seeds were placed in the field from November 4, 1932, to January 9, 1933, and the plants taken up from March 16, 1933, to March 21, 1933. The great variation in time of planting of the different plants might be expected to cause considerable variation in the infestation. However, from the results, it seems to have had very little effect.

The planting was made on heavily infested soil, and, to make doubly sure that the plants were exposed to the attack of the nematode, infested roots of whip-poor-will cowpeas and tomatoes were placed in the rows at time of planting. Triplicate plots were used, 11 plants being set out in each plot. In a few cases where seed was planted in the field more than 33 plants were raised. In some cases the mortality was high due to unfavorable field conditions. This plot was on high, sandy ground, containing very little humus and with no protection from the sun. During dry periods the plants were irrigated by shallow ditches between the rows, the water being pumped to the higher side of the plot and turned into the ditches.

Planting No. 2.—This planting was made from March 28 to April 10, 1933, and the plants were taken up on July 19 and 20. Because of a change in the irrigation system, it was necessary to change the location of the plot. Again infested ground was selected and infested roots from the first planting were cut up and worked into the soil. Nevertheless, the infestation of root-knot in this planting was lighter than in the preceding one.

Due to damage in the irrigation system which could not be immediately repaired, a number of plants were lost during dry weather. In this planting duplicate plots were used, starting with 26 plants of each variety tested in each plot.

The plot on which these plants were grown was of the same soil type as that used in the first planting. When the plants were taken up the plot was plowed and sowed to whip-poor-will cowpeas to maintain the infestation of root-knot for the next planting.

Planting No. 3.—This planting was made on December 1, 1933, and January 1, 1934, and the plants were taken up from April 19 to April 26, 1934. Five plots were used with five plants of each variety in each plot. The infestation seemed to be uniform throughout.

Planting No. 4.—This planting was made from March 5 to March 27, 1934, and the plants were taken up from June 2 to June 6, 1934.

With this planting which was practically the same as No. 3, the most satisfactory method of laying out the plot was found. Five plots were used with seven plants in each. Each row was

52½ feet long and divided into seven parts, each 7½ feet long. Seven plants were placed in each part. The rows were 18 inches apart and as there were 49 kinds of plants each plot consisted of seven rows. Thus, the whole area covered by the five plots lying side by side was a 52½ foot square. This eliminated the chance of the wide variation of infestation that might occur in large areas and made the plots easier to irrigate.

TABLE 1.—TOTAL NUMBER OF EACH KIND OF PLANT, DEGREE OF INFESTATION BY ROOT-KNOT, AND NUMBER AND PERCENTAGE OF PLANTS IN EACH GROUP FOR PLANTING NO. 1, WINTER OF 1932.

Plants	Number of Plants and Percentages Infested												
	Total Number	Very Heavily Infested		Heavily Infested		Mod. Infested		Lightly Infested		Very Lightly Infested		Not Infested	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Blue laceflower	32	32	100										
Calendula	29	29	100										
Gypsophila	22	21	95	1	5								
Helichrysum	33	30	91	3	9								
Pansy	21	19	90	2	10								
Cynoglossum	28	25	89	3	11								
Ann. sweet pea	27	23	85	4	15								
Lobelia	31	22	71	9	29								
Snapdragon	32	25	78	3	9	4	13						
Centaurea	33	16	49	15	45	2	6						
Radio calendula	14	9	65	2	14	2	14	1	7				
Salpiglossis	15	4	26	10	67	1	7						
Hollyhock	20	7	35	10	50	2	10			1	5		
Matricaria	15			15	100								
Nasturtium	45	2	4	31	69	12	27						
Aquilegia	20	1	5	13	65	5	25	1	5				
Linaria	32	6	19	13	40	7	22	5	16			1	3
California poppy	32	7	22	11	34	8	25	4	13			2	6
Sunflower	56			35	62	12	22	9	16				
Acroclinium	19	1	5	7	37	5	26	6	32				
Verbena	31			14	45	8	26	9	29				
Marg. carnation	30			14	45	3	10	9	30	3	10	1	3
Physalis	18			3	17	1	5	7	39	7	39		
Petunia	30			1	3	7	23	12	40	10	34		
Godetia	22			3	13	1	5	11	50	6	27	1	5
Shasta daisy	13					2	15	6	46	5	39		
China aster	21					8	38	3	14	7	34	3	14
Phlox	33	4	12	1	3	2	6	10	30	5	15	11	34
Candytuft	30			2	7	5	17	6	20	10	33	7	23
Pinks	33	1	3	4	12	3	9	7	21	3	9	15	46
Stock	33									27	82	6	18
Zinnia	27							2	8	3	11	22	81
Gerbera daisy	9									1	11	8	89
Arctotis	32									1	3	31	97
Calliopsis	33									1	3	32	97
Sweet alyssum	25											25	100
Cosmos	26											26	100
Coreopsis	32											32	100
Michaelmas daisy	33											33	100
African marigold	65											65	100

EXPERIMENTAL RESULTS

As 25 plants seemed quite adequate for the data, the original planting of 35 plants gave a leeway for loss of some of them. Where all seven plants in a plot survived the data were taken on the five middle plants. Shortly after the plants were set in Plantings No. 3 and No. 4, infested roots and soil were spread and cultivated into the ground.

When the plants were taken up they were examined and classified as follows: (1) not infested, (2) very lightly infested, (3) lightly infested, (4) moderately infested, 5) heavily infested, and (6) very heavily infested. This classification was based on the number and size of the galls. In the first group no galls were found; in the second group were placed the plants which showed one or a few scattering galls; in the third the plants that had a number of small galls; in the fourth group the galls were either more numerous or larger than in the third; in the fifth a large percentage of the roots were infested with large galls; and in the sixth group practically all roots had a large number of large galls.

Tables 1 to 4 show the total number of each kind of plant used in the four plantings and the number of plants and percentages that come in the classifications just described.

TABLE 2.—TOTAL NUMBER OF EACH KIND OF PLANT, DEGREE OF INFESTATION BY ROOT-KNOT, AND NUMBER AND PERCENTAGE OF PLANTS IN EACH GROUP FOR PLANTING NO. 2, SPRING OF 1933.

Plants	Total Number	Number of Plants and Percentages Infested											
		Very Heavily Infested		Heavily Infested		Mod. Infested		Lightly Infested		Very Lightly Infested		Not Infested	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Celosia	50	50	100										
Morning-glory	50	36	72	9	18	3	6	2	4				
Centaurea	19	12	63	4	21	3	16						
Scarlet climber	50	6	12	17	34	12	24	15	30				
Sunflower	50			20	40	15	30	15	30				
Moonflower	25			5	20	6	24	6	24	8	32		
Arctotis	35			3	9	5	14	6	17	20	57	1	3
Blue laceflower	28					4	14	8	29	11	39	5	18
Portulaca	50							8	16	37	74	5	10
Vinca	50							1	2	37	74	12	24
Giant zinnia	42							1	2	21	50	20	48
Cosmos	39					1	3	1	3	14	36	23	59
Phlox	50							3	6	10	20	37	74
Verbena	15									4	27	11	73
Torenia	22									4	18	18	82
Four o'clock	50									5	10	45	90
Small zinnia	50									5	10	45	90
Calliopsis	10											10	100
Thunbergia	14											14	100
Gaillardia	35											35	100
African marigold	50											50	100

TABLE 3.—TOTAL NUMBER OF EACH KIND OF PLANT, DEGREE OF INFESTATION BY ROOT-KNOT, AND NUMBER AND PERCENTAGE OF PLANTS IN EACH GROUP FOR PLANTING NO. 3, WINTER OF 1933.

Plants	Total Number	Number of Plants and Percentages Infested											
		Very Heavily Infested		Heavily Infested		Mod. Infested		Lightly Infested		Very Lightly Infested		Not Infested	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Ann. sweet pea	25	19	76	6	24								
Lobelia	25	16	61	7	30	2	9						
Centaurea	25	17	68	5	20	3	12						
Larkspur	4	3	75			1	25						
Schizanthus	25	12	48	11	44	1	4	1	4				
Calendula	25	12	48	9	36	4	16						
Gilia	25	9	36	7	28	5	20	4	16				
Cynoglossum	21	3	14	10	48	8	38						
Pansy	25	9	36	7	28	3	12	6	24				
Snapdragon	22	14	64	4	18	1	5	1	5	2	9		
California poppy	25	9	36	7	28	1	4	6	24	2	8		
Dianthus	25	11	44	2	8	3	12	4	16	5	20		
English daisy	25	4	16	5	20	12	48	4	16				
Candytuft	25	3	12	5	20	9	36	7	28	1	4		
Dimorphotheca	25	2	8	6	24	10	40	5	20	2	8		
Hunnemannia	17	3	18	4	23	2	12	6	35	2	12		
Shasta daisy	25	3	12	8	32	5	20	4	16	5	20		
Nicotiana	25	2	8	5	20	8	32	10	40				
Poppy	25	1	4	7	28	8	32	4	16	5	20		
Gypsophila	25	3	12	5	20	3	12	9	36	5	20		
Petunia	25			4	16	9	36	9	36	3	12		
Mignonette	25			6	24	5	20	9	36	5	20		
Acroclinium	25	1	4	1	4	7	28	13	52	3	12		
Gerbera daisy	24			1	4	6	25	16	67	1	4		
Stock	25	1	4	2	8	3	12	15	60	4	16		
Per. sweet pea	25	2	8	3	12	5	20	5	20	5	20	5	20
Linaria	23	2	9	2	9	3	13	5	21	10	44	1	4
Carnation	25	3	12	2	8	4	16	4	16	2	8	10	40
Godetia	24			1	4	5	21	7	29	7	29	4	17
Leptosyne	16			1	6	1	6	4	25	8	50	2	13
Statice	25					1	4	5	20	9	36	10	40
Phlox	25					1	4	3	12	9	36	12	48
Calliopsis	25									15	60	10	40
Arctotis	25			1	4					4	16	20	80
Michaelmas daisy	25							1	4	1	4	23	92
Lupine	15									1	7	14	93
Clarkia	3											3	100
Coreopsis	10											10	100
Four o'clock	23											23	100
Alyssum	25											25	100
Gaillardia	25											25	100

TABLE 4.—TOTAL NUMBER OF EACH KIND OF PLANT, DEGREE OF INFESTATION BY ROOT-KNOT, AND NUMBER AND PERCENTAGE OF PLANTS IN EACH GROUP FOR PLANTING NO. 4, SPRING OF 1934.

Plants	Total Number	Number of Plants and Percentages Infested											
		Very Heavily Infested		Heavily Infested		Mod. Infested		Lightly Infested		Very Lightly Infested		Not Infested	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Gourd	14	14	100										
Balsam	25	25	100										
Dolichos	8	8	100										
Celosia	25	21	84	4	16								
Lobelia	25	21	84	4	16								
Nasturtium	25	20	80	2	8	2	8	1	4				
Amaranthus	25	17	68	7	28	1	4						
Helichrysum	25	18	72	5	20	2	8						
Blue lace flower	25	18	72	4	16	1	4	2	8				
Morning-glory	20	13	65	4	20	3	15						
Sunflower	25	13	52	9	36	2	8	1	4				
Cardinal climber	20	8	40	5	25	5	25			1	5	1	5
Coleus	25	5	20	9	36	6	24	5	20				
Moonflower	20	8	40	3	15	3	15	3	15	3	15		
Dimorphotheca	25	6	24	8	32	5	20	4	16	2	8		
Ann. chrysanthemum	8			3	38	4	50	1	12				
Petunia	25	3	12	10	40	5	20	4	16	3	12		
Per. chrysanthemum	13	1	8	3	23	5	39	2	15	2	15		
Portulaca	25			7	28	10	40	6	24	2	8		
Artemisia	25			4	16	8	32	10	40	3	12		
Cypress vine	20			6	30	6	30	2	10	4	20	2	10
Cynoglossum	15			2	13	3	20	8	53	2	13		
Clarkia	13			1	8	5	38	3	23	4	31		
Liatris spicata	9			1	11	2	22	4	44	2	22		
Vinca	25			2	8	8	32	8	32	7	28		
China aster	25			2	8	3	12	14	56	5	20	1	4
Pentstemon	25	1	4	1	4	4	16	8	32	11	44		
Phlox nana comp.	25			1	4	6	24	3	12	11	44	4	16
Blue torenia	25							13	52	10	40	2	8
Phlox drm. stell.	25			1	4	3	12	5	20	10	40	6	24
Globe amaranth	25			2	8	1	4	2	8	16	64	4	16
Big drum. phlox	25			1	4	1	4	7	28	9	36	7	28
Dianthus	25	1	4			1	4	5	20	10	40	8	32
Alyssum	25							5	20	18	72	2	8
Thunbergia	25					1	4	7	28	10	40	7	28
Scarlet sage	20									20	100		
White torenia	25									21	84	4	16
Verbena	25					1	4	1	4	11	44	12	48
Four o'clock	15									8	53	7	47
Blue sage	10									5	50	5	50
Zinnia	25							1	4	7	28	17	68
Cosmos	25									2	8	23	92
Ageratum	25											25	100
Evening primrose	25											25	100
Rudbeckia	25											25	100
Argemone	21											21	100
French marigold	25											25	100
African marigold	25											25	100

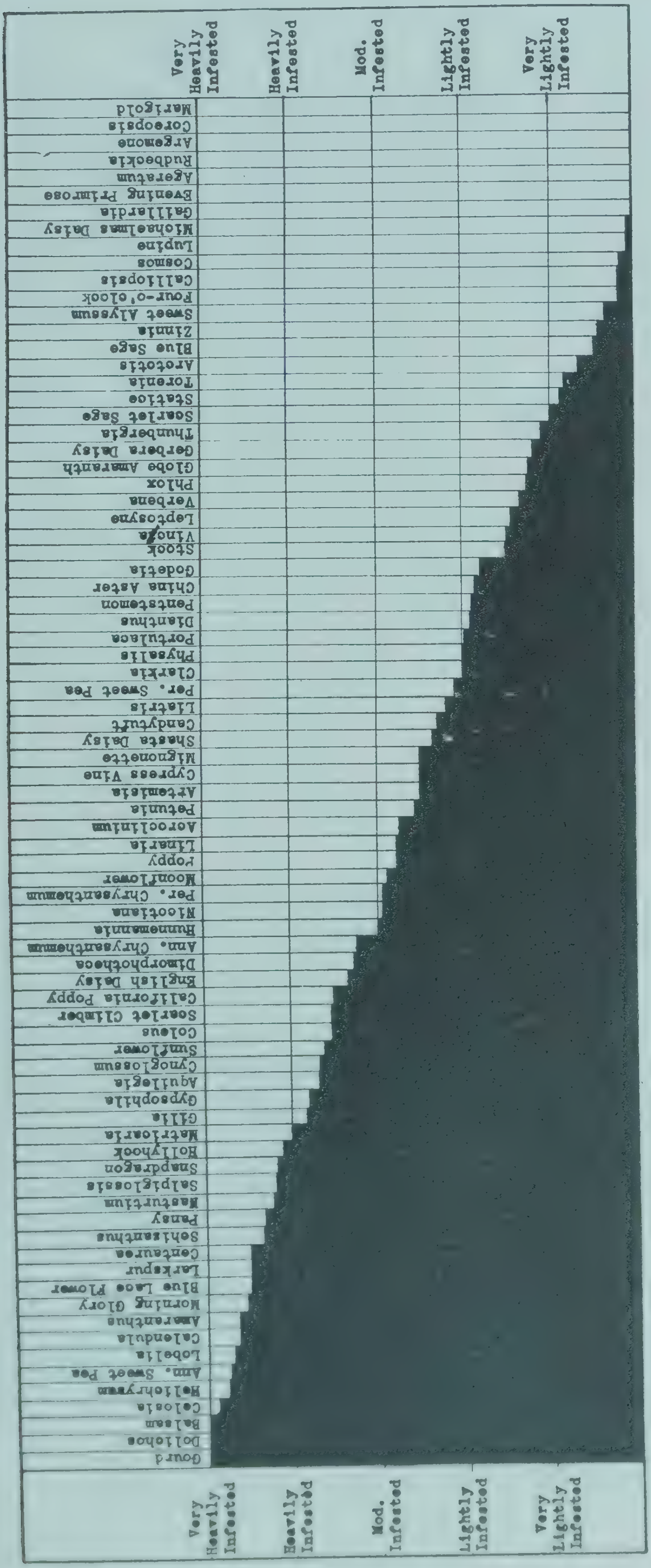

Fig. 1.—Relative susceptibility of some ornamental plants to root-knot, as determined by four experimental plantings on infested soil.

The following method was used in summing up and rating the plants for comparison. Arbitrary numbers were assigned for each degree of infestation. They were: 0—not infested, 20—very lightly infested, 40—lightly infested, 60—moderately infested, 80—heavily infested, and 100—very heavily infested. Each plant was rated and the average for each kind of plant found. Table 5 shows the rating for the different kinds of plants for each of four plantings. Figure 1 shows the relative susceptibility of the plants to root-knot as determined by the four plantings.

A great variation in degree of infestation of the various plants was noted. A few kinds of plants such as the marigolds seemed to be 100 percent resistant to the root-knot, while in the cases of gourd and celosia all the plants were heavily or very heavily infested under the same conditions. Between these extremes there was a great variation. In some species most of the plants were free of infestation but a few were very lightly infested. In other species, all degrees from no infestation to heavy infestation were found. Some of this may have been due to the degree of infestation of the nematodes in the soil, as there seemed to be a great variation in numbers even in small areas. However, there were cases of uninfested plants with heavily infested ones on each side of them.

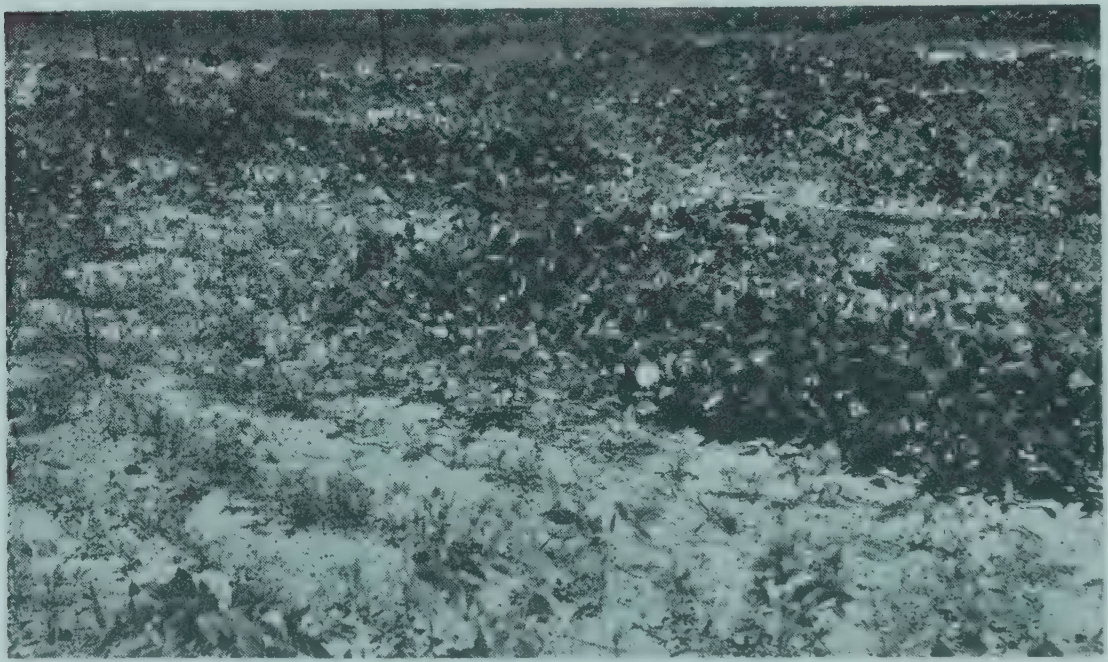

Fig. 2.—Whip-poor-will cowpeas, grown on the same area as experimental planting No. 3, were dead within two and a half months after the highly susceptible ornamentals were removed. In places where less susceptible ornamentals were grown, the cowpeas had survived.

TABLE 5.—RATE* OF THE ROOT-KNOT INFESTATION IN THE FOUR PLANTINGS.

Common Name	Scientific Name (After "Hortus", L. H. Bailey)	Plantings				
		Winter of '32	Spring of '33	Winter of '33	Spring of '34	Average
Acroclinium	*Helipterum roseum*	63	—	47	—	55
Ageratum	*Ageratum* sp.	—	—	—	0	0
Alyssum, sweet	*Lobularia maritima*	0	—	0	22	7.3
Amaranthus (molten fire)	*Amaranthus* sp.	—	—	—	93	93
Arctotis	*Arctotis stoechadifolia*	1	34	6	—	13.7
Argemone	*Argemone* sp.	—	—	—	0	0
Artemisia	*Artemisia sacrorum viride*	—	—	—	50	50
Aster, China	*Callistephus chinensis*	35	—	—	40	37.5
Balsam	*Impatiens balsamina*	—	—	—	100	100
Blue lace flower (Didiscus)	*Trachymene caerulea*	100	28	—	90	72.7
Butterfly flower	*Schizanthus* sp.	—	—	87	—	87
Calendula	*Calendula officinalis*	100	—	86	—	93
Calendula, radio	*Calendula officinalis*	87	—	—	—	87
Calliopsis	*Coreopsis tinctoris*	1	0	12	—	4.3
Candytuft	*Iberis umbellata*	30	—	62	—	46
Carnation	*Dianthus* sp.	—	—	36	—	36
Carnation, Marguerite	*Dianthus* sp.	57	—	—	—	57
Celosia	*Celosia argentea* var.	—	100	—	97	98.5
Centaurea	*Centaurea cyanus*	89	90	91	—	90
Chinese forget-me-not	*Cynoglossum* sp.	98	—	75	47	73.3
Chrysanthemum, annual	*Chrysanthemum coronarium*	—	—	—	65	65
Chrysanthemum, perennial	*Chrysanthemum* sp.	—	—	—	59	59
Clarkia	*Clarkia* sp.	—	—	0	45	22.5
Coleus	*Coleus* sp.	—	—	—	71	71
Columbine	*Aquilegia* sp.	74	—	—	—	74
Coreopsis	*Coreopsis lanceolata*	0	—	0	—	0
Cosmos	*Cosmos bipinnatus*	0	10	—	2	4
Cypress vine	*Quamoclit pennata*	—	—	—	50	50
Daisy, English	*Bellis perennis*	—	—	67	—	67
Daisy, Gerbera	*Gerbera jamesoni*	2	—	46	—	24
Daisy, Michaelmas	*Aster tradescanti*	0	—	2	—	1

TABLE 5.—RATE* OF THE ROOT-KNOT INFESTATION IN THE FOUR PLANTINGS.—*Continued.*

Common Name	Scientific Name (After "Hortus", L. H. Bailey)	Plantings				
		Winter of '32	Spring of '33	Winter of '33	Spring of '34	Average
Daisy, Shasta	*Chrysanthemum maximum*	35	—	60	—	47.5
Dianthus	*Dianthus* sp.	—	—	68	22	45
Dimorphotheca	*Dimorphotheca aurantiaca*	—	—	61	70	65.5
Dolichos	*Dolichos* sp.	—	—	—	100	100
Evening primrose	*Oenothera lamarkiana*	—	—	—	0	0
Four-o'clock	*Mirabilis jalapa*	—	2	0	11	4.3
Gaillardia	*Gaillardia* sp.	—	0	0	—	0
Gilia	*Gilia* sp.	—	—	77	—	77
Globe amaranth	*Gomphrene globosa*	—	—	—	25	25
Godetia	*Godetia* sp.	39	—	33	—	36
Gourd	*Cucurbita* sp.	—	—	—	100	100
Gypsophila (Baby'sbreath)	*Gypsophila* sp.	99	—	54	—	76.5
Helichrysum	*Helichrysum* sp.	98	—	—	93	95.5
Hollyhock	*Althaea rosea*	82	—	—	—	82
Hunnemannia	*Hunnemannia fumariaefolia*	—	—	60	—	60
Lantern ground cherry	*Physalis francheti*	40	—	—	—	40
Larkspur	*Delphinium* sp.	—	—	90	—	90
Leptosyne	*Coreopsis* sp.	—	—	29	—	29
Liatris	*Liatris spicata*	—	—	—	44	44
Linaria	*Linaria* sp.	71	—	41	—	56
Lobelia	*Lobelia erinus*	94	—	91	97	94
Lupine	*Lupinus* sp.	—	—	1	—	1
Marigold, African	*Tagetes* sp.	—	0	—	0	0
Marigold, French	*Tagetes* sp.	—	—	—	0	0
Matricaria	*Matricaria* sp.	80	—	—	—	80
Mignonette	*Reseda odorata*	—	—	50	—	50
Moonflower	*Calonyction* sp.	—	46	—	70	58
Morning-glory	*Ipomoea* sp.	—	92	—	90	91
Nasturtium	*Tropaeolum* sp.	76	—	—	93	84.5
Nicotiana	*Nicotiana alata*	—	—	59	—	59
Pansy	*Viola tricolor*	98	—	75	—	86.5

TABLE 5.—RATE* OF THE ROOT-KNOT INFESTATION IN THE FOUR PLANTINGS.—*Continued.*

Common Name	Scientific Name (After "Hortus", L. H. Bailey)	Plantings				
		Winter of '32	Spring of '33	Winter of '33	Spring of '34	Average
Pentstemon	*Pentstemon* sp.	—	—	—	38	38
Periwinkle	*Vinca rosea*	—	16	—	44	30
Petunia	*Petunia hybrida*	39	—	51	65	51.7
Phlox, Big Drummond	*Phlox drummondi*	33	6	14	24	19.3
Phlox, Dwarf	*Phlox nana compacta*	—	—	—	31	31
Phlox, Starred	*Phlox drummondi stellaris*	—	—	—	26	26
Pink	*Dianthus* sp.	29	—	—	—	29
Poppy	*Papaver* sp.	—	—	56	—	56
Poppy, California	*Eschscholtzia californica*	69	—	72	—	70.5
Portulaca	*Portulaca* sp.	—	21	—	58	39.5
Rudbeckia	*Rudbeckia* sp.	—	—	—	0	0
Sage, blue	*Salvia farinacea*	—	—	—	10	10
Sage, scarlet	*Salvia splendens*	—	—	—	20	20
Salpiglossis	*Salpiglossis sinuata*	84	—	—	—	84
Scarlet climber	*Quamoclit sloteri*	—	66	—	76	71
Snapdragon	*Antirrhinum majus*	93	74	—	—	83.5
Statice	*Limonium sinatum*	—	—	18	—	18
Stock	*Matthiola* sp.	16	—	45	—	30.5
Sunflower	*Helianthus annuus*	69	62	—	87	72.7
Sweet pea, annual	*Lathyrus odoratus*	97	—	95	—	96
Sweet pea, perennial	*Lathyrus latifolius*	—	—	42	—	42
Thunbergia	*Thunbergia* sp.	—	—	—	22	22
Torenia, blue	*Torenia fournieri*	—	4	—	29	16.5
Torenia, white	*Torenia* sp.	—	—	—	17	17
Verbena	*Verbena* sp.	63	5	—	13	27
Zinnia, giant	*Zinnia elegans*	—	11	—	—	11
Zinnia, small	*Zinnia elegans*	5	2	—	7	4.7

* 0 = not infested, 20 = very lightly infested, 40 = lightly infested, 60 = moderately infested, 80 = heavily infested, and 100 = very heavily infested.

FACTORS OF INFESTATION

In some of these cases there was indication that wide variation in susceptibility to nematode attack may exist within the same kind of plant. In the Dianthus group there was a wide range of susceptibility, either between different types or individuals of the same type. By careful selection, highly resistant strains might be found or developed with some of these plants.

Some types of plants seem to exhibit considerable tolerance to the attacks of the nematodes. The roots may have great masses of galls and yet the plant may be quite vigorous. However, with plants of this type the supply of water seems to be a very important factor. If the ground becomes dry these plants wilt very badly. Snapdragons and Centaurea are examples.

Temperature is important in the root-knot problem. There are at least two factors involved. The development of the nematode is greater in spring and summer than in winter, so that a plant which may not be heavily infested during the winter may be so heavily attacked as to be greatly injured or killed during warmer seasons. The warmer weather is, also, unfavorable to some kinds of plants so that their vitality is lowered and they are more readily injured by root-knot.

RELATIVE SUSCEPTIBILITY

Below is a list of ornamentals grown during the four plantings. These plants have been listed in the order of their susceptibility to the attack of the nematode as shown by the plantings, taking into consideration the damage to the plants. For the most part they are listed according to the method of rating discussed previously. However, that order is changed in some cases where one kind of plant shows more damage than a more heavily infested one, i.e., less tolerance.

Not infested
- Marigold
- Coreopsis
- Argemone
- *Rudbeckia bicolor*
- *Ageratum* sp.
- Evening primrose
- Gaillardia

Very lightly infested
- Michaelmas daisy
- Lupine
- Calliopsis
- Four-o'clock
- Cosmos
- Zinnia
- Sweet alyssum
- Torenia
- Thunbergia
- Blue sage
- Arctotis
- Phlox
- Statice
- Scarlet sage
- Globe amaranth
- Gerbera daisy
- Vinca

- Stock
- Leptosyne

Lightly infested

- Godetia
- China aster
- Pentstemon
- Dianthus
- Portulaca
- Verbena
- Lantern groundcherry
- Perennial sweet pea
- *Liatris spicata*
- Clarkia
- Shasta daisy
- Candytuft
- Mignonette
- Cypress vine
- Artemisia
- Petunia

Moderately infested

- Acroclinium
- Linaria
- Poppy
- Moonflower
- Perennial chrysanthemum
- Nicotiana
- Hunnemannia
- Annual chrysanthemum
- Dimorphotheca
- English daisy
- Scarlet climber or Cardinal climber
- California poppy

Heavily infested

- Coleus
- Aquilegia
- Helianthus
- Chinese forget-me-not or Cynoglossum
- Gypsophila
- Gilia
- Matricaria
- Nasturtium
- Snapdragon
- Hollyhock
- Salpiglossis
- Pansy
- Centaurea

Under dry conditions heavily infested plants of the last 6 in this group wilt seriously.

Very heavily infested	
Schizanthus	
Morning-glory	Some plants very badly damaged
Larkspur	
Lobelia	
Helichrysum	Some plants greatly stunted
Amaranthus	Most plants greatly stunted
Calendula	" " " "
Balsam	" " " "
Blue lace flower	Plants very badly stunted
Annual sweet pea	Most of plants badly damaged, some killed
Celosia	" " " " " " "
Dolichos	" " " " " " "
Gourd	" " " " " " "

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UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
GAINESVILLE, FLORIDA
WILMON NEWELL, Director

COLD STORAGE STUDIES OF FLORIDA CITRUS FRUITS

I. Effect of Temperature and Maturity on the Changes in Composition and Keeping Quality of Oranges and Grapefruit in Cold Storage

By

ARTHUR L. STAHL AND A. F. CAMP

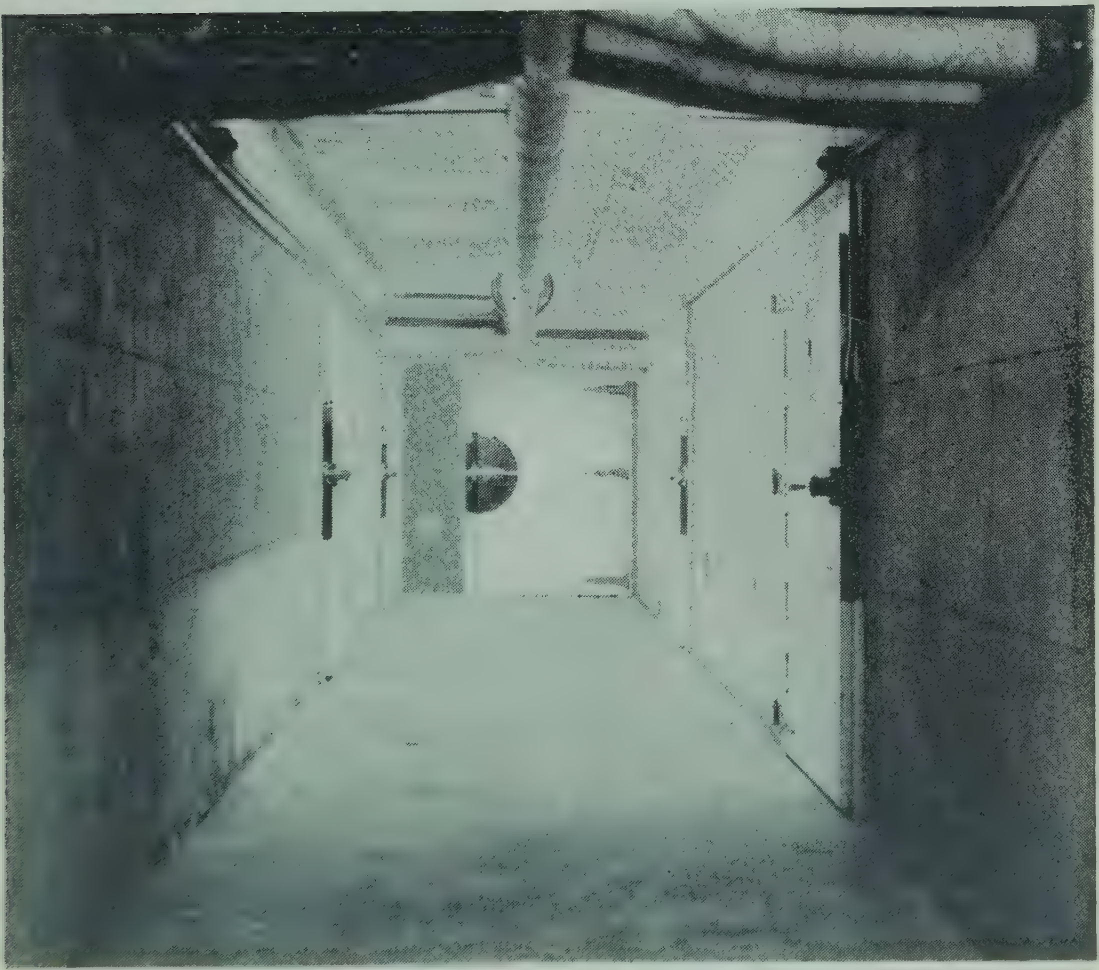

Fig. 1.- The hall in the refrigerating plant is kept cool so that when doors are opened into cold storage rooms the rooms do not fill with hot air, causing violent fluctuation in temperatures.

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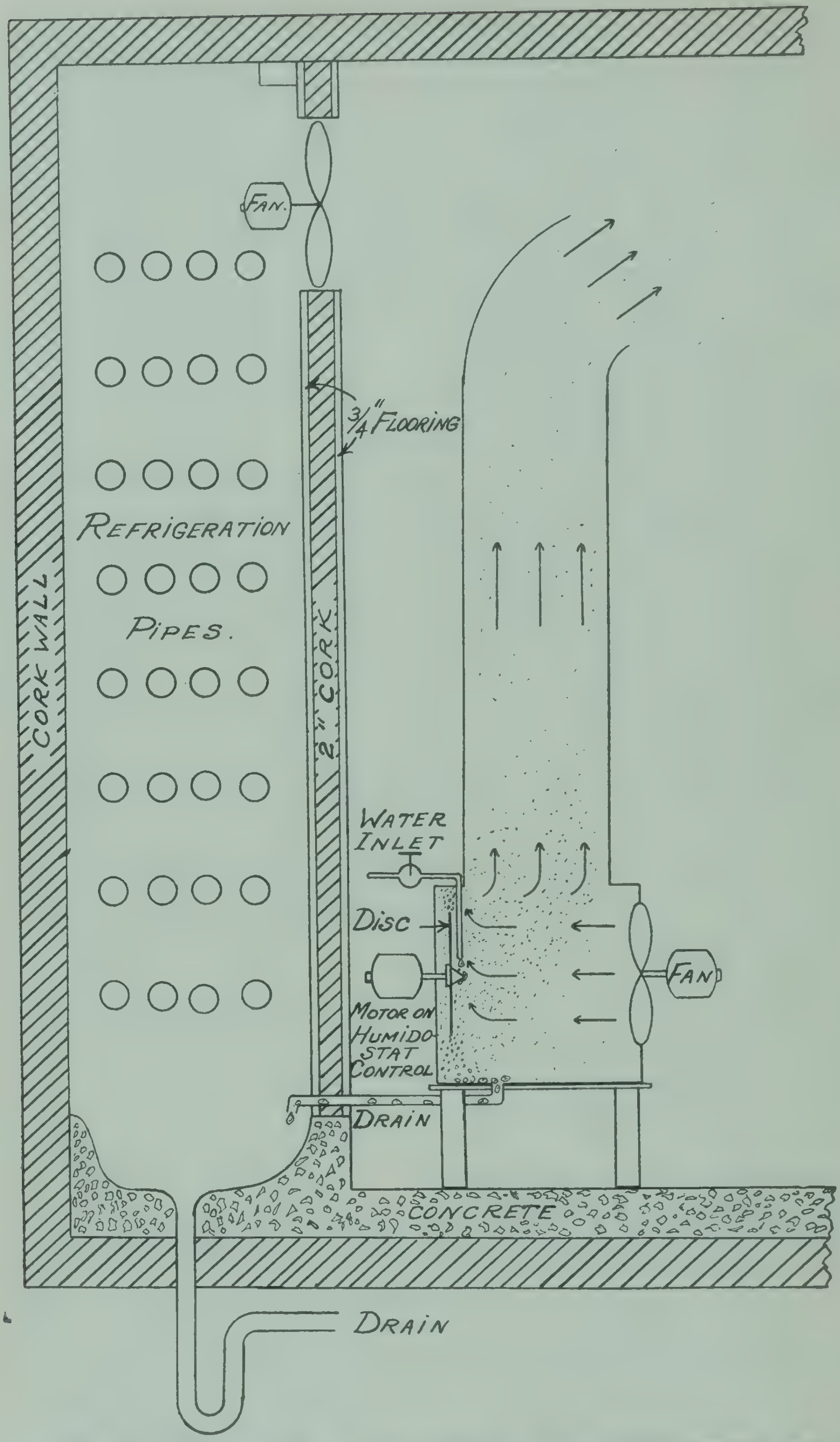

Fig. 2.—Vertical section of refrigerating room, showing bunker wall separating brine pipes from main room (see front view of bunker wall in Fig. 3). Also vertical section of humidifier, with arrows indicating air currents carrying water vapor (stippled) into room.

COLD STORAGE STUDIES OF FLORIDA CITRUS FRUITS

I. Effect of Temperature and Maturity on the Changes in Composition and Keeping Quality of Oranges and Grapefruit in Cold Storage

By ARTHUR L. STAHL AND A. F. CAMP

INTRODUCTION

The use of refrigeration in the marketing of fruits and vegetables has become, during the last few years, a commonplace matter. In fact, it is largely refrigeration that has made possible the transportation of products from widely separated areas of production to the large consuming centers. Without refrigeration the diet in populous areas would be decidedly circumscribed, due to shortage of fresh fruits and vegetables at certain seasons of the year, particularly during the winter months.

While refrigeration has been used to a considerable extent in the transportation of citrus, comparatively little research has been devoted to its application to other phases of its use. As a result, citrus fruit is usually marketed as soon after picking as possible. This is in marked contrast to the marketing of such products as apples, and pears, refrigeration being used to extend and stabilize the marketing period for these products. In some producing areas citrus is harvested throughout the year, while in Florida the bulk of the crop is harvested within a period of seven months with peak shipments within six months. Undoubtedly, refrigeration will be used as an aid in marketing citrus to a much greater extent in the future.

Refrigeration research may yield beneficial results in three phases of citrus marketing: (1) In the improvement of equipment and methods for refrigeration in transit; (2) in the development of methods and equipment for short periods of refrigeration to stabilize the market at time of over-shipment, and (3) in the development of methods for holding fruit in cold storage for periods of two to five months in areas where such long holds may be profitable.

Improvements in transit refrigeration may be expected to produce improved equipment for pre-cooling and handling and also a better understanding of the effects of low storage temperatures on behavior of fruit after removal from storage. The latter point has probably been insufficiently stressed during the development of pre-cooling and it is quite probable that at times the temperatures used in this work have been too low. It is not sufficient to deliver fruit in good shape at the point of destination. Its keeping quality after removal to the retailer and the consumer must be considered. Another point on which too little information is available is the effect of vigorous blasts of cold air on the fruit and particularly on the development of storage pitting. Much information along these lines may be developed in cold storage research and later applied to transit work.

During the last few years the occurrence of over-supplies of citrus in the markets, with the attendant depressions in prices, has become increasingly common. If it were safe, at such times, to move fruit into cold storage for a short period to give the supply a chance to lighten, much might be gained. This frequently has been attempted but too often has been attended by disastrous results. The offering of fruit injured in cold storage has undermined the faith of buyers and resulted in extreme caution. Marketing should become decidedly more orderly if and when methods are worked out so that fruit can be put in cold storage for short holds with the certainty that the fruit, when removed from storage, will be of good quality. With such storage available the seller would no longer feel the necessity for disposing of the shipment at once, regardless of price, and this in itself would add considerably to the seller's confidence.

The matter of holding citrus fruits for as long as two to five months is an exceedingly complicated one. Development of methods for doing this is, however, much less complicated than the solution of the marketing problems. While it is true that Florida does not ship citrus during the summer months and competing areas ship but little grapefruit during that period, nevertheless the sale for fruit during this period in the North might be insufficient to pay for storing it. This is brought about by the fact that other fresh fruits are present in profusion on those markets during the summer, and at prices which would make competition difficult. This is not so true, however, of Florida itself and contiguous areas where fruits are likely to be scarce during that period. Within our own state there is apparently a potential market available for high quality cold storage oranges with the possibility of developing some market for grapefruit. The problem of trade acceptance is complicated by the fact that third grade fruit has been stored in the past and under improper conditions, and the fruit would not stand up after removal from storage. While research may well point the way to the successful holding of fruit for long periods, nevertheless it also will be necessary to develop confidence in the stored product.

Research on the cold storage of citrus has two very definite phases. The first deals with the effect of temperatures, humidities, wrappers and surface treatments on the character of the fruit itself, i. e., on its retention of good appearance and market quality. The second phase deals with problems of disease control, more particularly stem-end rot, which has been a persistent problem in cold storage work. If decays could be controlled by pre-storage treatment, it would be comparatively easy to establish methods for holding the fruit in good shape. Without control of decay by pre-storage treatment it becomes necessary to control it by temperatures and the temperatures desirable for decay control may not at all conform to the temperatures most suitable to the fruit itself. Without decay control by treatment it becomes necessary to compromise the two phases of the problem and the results frequently are unsatisfactory in both directions.

In the experimental refrigeration plant herein described, a great deal of work has been done during the last few years covering the effects of temperatures, humidities, wrappers, treatments, chemical composition, varieties and, to some extent, cultural treatments. The wide field covered and the large amount of data collected make it impossible to present in one bulletin all information that may be of value. A series of bulletins is therefore being prepared and will be presented for publication as they are ready.

The investigations forming the subject of this first bulletin were concerned with the effect of temperature and maturity on keeping quality and changes in composition of untreated, unwrapped oranges and grapefruit.

Citrus in all stages of maturity is being stored at temperatures ranging from 30° to 80° F. at present in the commercial storage houses and any information on the superiority of certain temperatures, humidities, methods of handling and optimum degree of ripeness in preserving the quality of the fruit during and after storage should prove of considerable interest and importance to the citrus industry.

In any cold storage investigations of citrus fruits, it is desirable to know the physiology of the fruit and the changes which go on in it after it is removed from the tree and held at storage temperatures. When the chemical and physical changes taking place in the fruit before and during storage at various temperatures are known, the many problems encountered in the storage of oranges and grapefruit can be more intelligently investigated.

PREVIOUS WORK

Experiments conducted by Hawkins and Magness (*8*)[1] in 1920 showed that pitting, one of the most serious problems to be met with in the cold storage of citrus, was less serious at relatively high cold storage temperatures (about 45° F.). More recent work by Hawkins and Barger (*7*) indicates that, under certain conditions, relatively low cold storage temperatures (31°-32° F.) give best results. They point out that "curing" the fruit at about 70° F. for 10 days materially reduced the amount of "pitting" in the stored fruit. They also found that the Marsh Seedless grapefruit was not well adapted to cold storage.

Overholser (*13*), working on marine refrigeration of California oranges, found the temperatures of 36°-38° F. most satisfactory. Higher temperatures resulted in wilting of the fruit and excessive losses from decay, and lower temperatures resulted in deterioration (pitting) of the rind.

Young and Read (*16*), working in Australia with Washington Navel and Valencia oranges, found that carefully handled fruit kept better than fruit handled in the ordinary way. They found that fruit which had not been through the commercial packing plant kept much better in cold storage than commercial fruit. They also thought that sweating, which took place during transportation, added to the keeping qualities of the unwrapped fruit. Fruit transported loosely in boxes held up much better than packed fruit. These investigators reported that relatively high cold storage temperatures (around 45° F.) gave most satisfactory results. They also reported little change in sugar content of the juice during storage.

Friend and Bach (*5*), working with Texas citrus fruit, found a temperature of 45° F. best suited for cold storage of grapefruit and 31°-32° F. most satisfactory for holding Valencia oranges in storage. They were able to keep grapefruit eight to 10 weeks and oranges as long as 20 weeks.

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[1] Italic figures in parentheses refer to "Literature Cited" in the back of this bulletin.

The chemical and physical characteristics of ripe citrus fruits have received a good deal of attention but little work has been done on the changes taking place in these constituents during storage. Chace, Tolman, and Munson (*2*), in their work on tropical fruits, analyzed several different varieties of citrus. König (*10*) has reported analyses of a large number of oranges of different varieties and, in a few cases, results have been given for analyses made upon more than one occasion during the same season. In a paper by Juritz (*9*) on citrus fruits, effect of age upon composition of oranges was briefly discussed.

Another investigation along these lines was carried out by Bigelow and Gore (*1*), who employed two varieties of oranges for this purpose, namely, St. Michael and Navel. They state that the changes after picking take place to a considerably lesser degree in oranges than in other fruits. McDermott (*11*) published a paper on the ripening of Florida oranges, but this author dealt more particularly with the enzymes in the peel.

Most of the investigation on the changes in composition of citrus fruits has been done on the acid and sugar content of the pulp or juice and of soluble solids present in the juice, in an attempt to obtain data on which maturity laws could be based. Rose (*14*) and others connected with the Florida State Department of Agriculture have made many analyses of citrus fruits in working out a basis for the regulation of their shipment.

Collison (*3*) determined the acids and sugars in the juice of several varieties of oranges, grapefruit and tangerines picked at various times during the season. He found, in general, that there was a decrease in acidity and an increase in sugar content as the season advanced and that after the fruit matured the sucrose was gradually broken down to reducing sugars. The fruits were analyzed shortly after removal from the tree.

Zoller (*17*) found that the acid of the pulp decreased during storage and records a marked increase in sugars after the fruit is removed from the tree. He also found that the content of the glucoside naringen, which is the bitter principle of grapefruit, was less in the peel after storage. This writer apparently used only a small number of fruits in his storage experiments, the work being for the most part a chemical study of the various constituents of the fruit.

Hawkins (*6*) has studied the changes which occur in grapefruit during development on the tree, five pickings being made during a period of four months.

Hawkins and Magness (*8*) studied the changes in Florida grapefruit during storage, particular attention being paid to the sugar and acid content of the pulp or edible portion of the fruit as influenced by six different storage temperatures. It was found that the acid content decreased in cold storage while the total sugar content remained about the same. The percentage of cane sugar decreased and the reducing sugar content increased. At the higher temperatures (about 55° to 60°; 70° and 86° F.) there was in some cases apparently an increase in acidity and a reduction in amount of sugar, especially in fruit stored for long periods. At these temperatures there is evidence that this increase in percentage of acid is not due entirely to loss of water from the pulp, but that there is an increase in amount of acid present.

Mann and Cooper (*12*) recently published a bulletin giving several modified types of precooling and car refrigeration which have proven superior to the standard refrigeration in transit. Results of these tests showed no significant relation between method of refrigeration and spoilage. Loss in weight of the fruit in transit was determined largely by temperature.

THE EXPERIMENTAL REFRIGERATION PLANT

The cold storage plant in which this work was carried on was designed primarily for research and presents some variations from the standard commercial practice. For this reason a description of the plant is given at this point so that the reader will have an understanding of the conditions under which the experiments were conducted. The cold storage rooms are arranged along both sides of a hall which is also insulated and refrigerated. While the hall is not automatically controlled as to temperature, sufficient uninsulated brine pipe was left on the return lines so that the hall temperature is maintained at 40° to 45° F. (Fig. 1.) Since the rooms are ordinarily operated on a range of temperatures from 32° to 60° F., this temperature is about midway on the scale and the rooms thus open into a closed hall with a temperature not far from that being maintained in the rooms. This prevents the inrush of warm air which takes place when refrigeration rooms are opened to outside temperatures and eliminates fluctuations in temperature and the precipitation of moisture commonly associated with such conditions. All rooms and the hall are insulated with cork board in the customary way.

Brine is used as the refrigerating medium in order to eliminate the possibility of ammonia leaks in the rooms. The method of application is somewhat similar to that described by Overholser (*13*), and is designed to give accurate temperature control. The brine pipes are arranged at the end of the room over a concrete drain (Fig. 2).

A movable wall insulated with 2″ of cork board and 1½″ of wood separates the pipes from the room, thus forming a bunker at the end of the room. The bunker is at right angles to the wall in which the door is located and has in the upper corner next to the door an opening fitted with a 12″ fan and, in the lower corner diagonally away from the fan, an opening in which is inserted a 12″ automatic shutter. The fan draws cold air from the bunker and the automatic shutter allows the warmer air from the room to go into the bunker when the fan is running and closes when the fan stops (Fig. 3).

The flow of brine is controlled by means of an automatic syphon valve which is set to hold the temperature in the bunker 4° to 6° F. below room temperature. This valve does not shut off sharply but acts as a metering valve. The fan is controlled by the thermo-regulator in the room. The rising temperature in the room starts the fan which draws cold air from the bunker and expels it into the room; the withdrawal of air from the bunker opens the automatic shutter and allows air from the room to flow through the bunker to the fan, passing over the brine coils in the process. It will be noted that this direction of circulation is opposite to that which would normally take place, i. e., the cold air from the bunker is expelled along the ceiling of the room and when the fan is stopped the resumption of the normal gravity flow is prevented by the automatic shutter. This scheme was followed mainly for two reasons; a better mixing of the cold air with the warm air in the room is obtained, and the mechanical operation of the automatic shutter is better.

In order to give accurate temperature control throughout the room the circulating fan on the humidifier (to be described below) is allowed to run continuously. This fan takes air from near the floor and expels it against the ceiling. The fan handles about 1,000 cubic feet of air per minute and with rooms having a volume of about 1500 cu. ft. the mixing of the air is quite efficient and the temperatures throughout the room are very nearly the same. Accurate temperature control is maintained at all times.

Whenever the temperature rises enough to actuate the thermoregulator in the room, the fan in the bunker wall expels cool

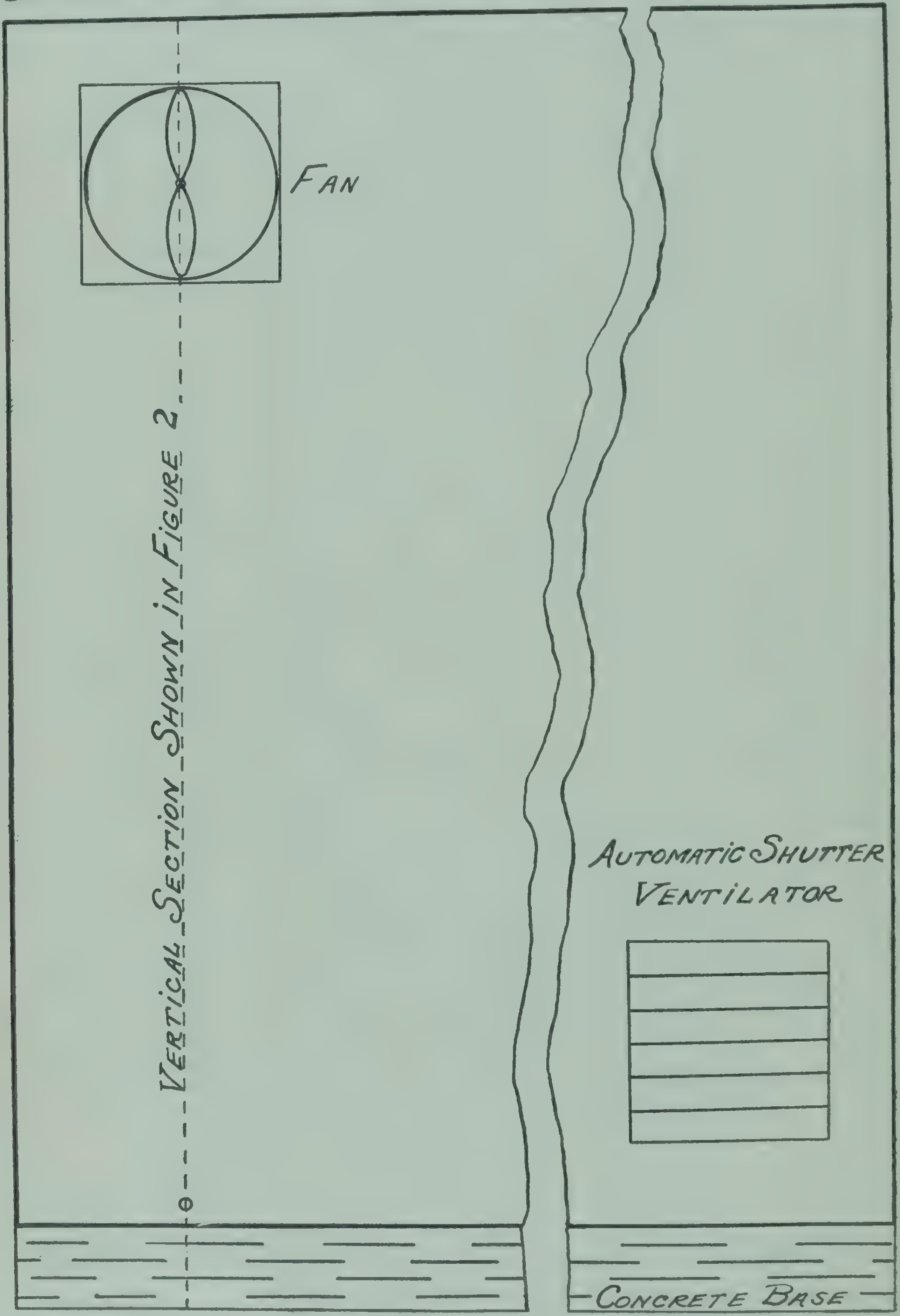
FAN
VERTICAL SECTION SHOWN IN FIGURE 2.
AUTOMATIC SHUTTER VENTILATOR
CONCRETE BASE

Fig. 3.—Front view of bunker wall, showing fan and automatic shutter.

air into the room until the temperature falls sufficiently to cause the thermo-regulator to cut off the fan. Due to the fact that the bunker is insulated from the room there is no super-cooling from the brine coils and the temperature drop is stopped immediately on stopping the fan. The volume of the bunker is small so that, even though the temperature of the air in the bunker might fall considerably below that of the room, the fan does not expel sufficient cold air from the bunker into the room to change the temperature of the room quickly, and consequently always has to run for some time, thus circulating the air in the room over the brine coils and resulting in a very gradual drop in the room temperature. As a result, there is no condensation of moisture or shock to the stored produce due to a sudden influx of cold air into the room.

Humidity control presented a rather difficult problem. It is necessary to add moisture to the atmosphere of the room to replace that which is continually being frozen out on the brine pipes. When these are defrosted the resultant water remains in the bunker and passes out through the drain rather than being returned to the room. The amount of moisture that has to be added when the rooms are held at high humidities is large and some mechanical method of adding it is necessary. The equipment used for this is shown in Figures 2 and 4.

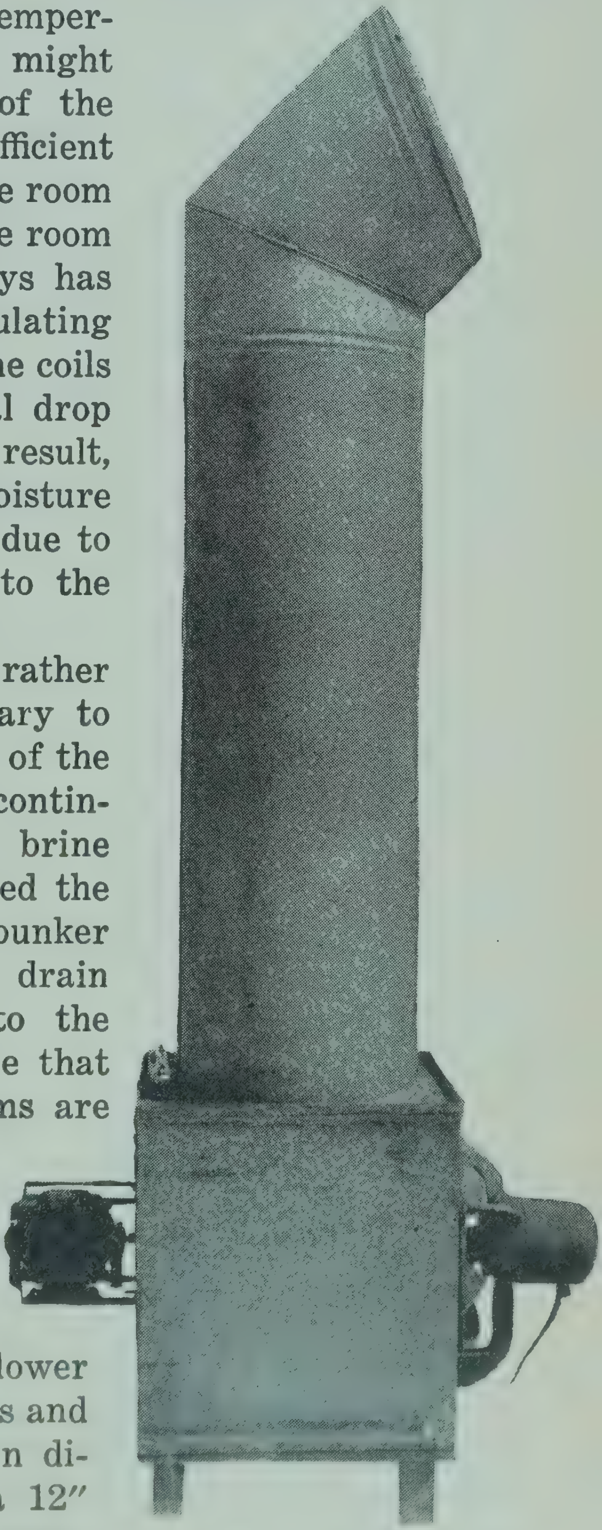
Fig. 4.—Side view of humidifier. (See cross-section sketch, Fig. 2.)

The equipment consists of a lower chamber about 16″ in dimensions and a stack about 4′ high and 1′ in diameter. In one side of this a 12″ fan is inserted into a suitable opening. This fan runs continuously and furnishes the air circulation in the room as above mentioned. On the opposite side of the chamber is a light metal disk 12″ in diameter, mounted on the shaft of a motor. In the center of the disk is a brass cone and a copper tube is so adjusted as to allow water to drip constantly on this cone. When the motor is turning the disk the water travels outward to the periphery and is thrown off as a fine mist and the current of air forced through the chamber by the fan picks up moisture. The peripheral speed of the disk determines to a considerable extent the fineness of the mist and the consequent rate of moisture pickup by the moving air. Where a relative humidity no higher than 90% is required and the air in the room is relatively moist to begin with, as it is in Florida, a 12″ disk rotating at 1725 r. p. m. is fairly efficient but, for higher humidities, a higher speed disk is desirable and in some cases a motor running at 3450 r. p. m. was used to advantage. The motor operating the disk is controlled by the humidostat while the fan runs continuously. The ordinary cycle is for the disk to start shortly after the thermo-regulator starts the bunker fan and continues to run for a short time after the bunker fan has stopped.

The humidostat has, as the sensitive element, a strip of the membrane used on the drum of a banjo. A strip of this extracted with ether to remove all fatty substances is very sensitive to moisture. The expansion and contraction of a strip 2″ x 12″ is used to operate either tungsten or mercury contact points. As long as the membrane is clean, it makes a very satisfactory element, though it needs some readjustment from day to day. When carefully operated and checked each day with a psychrometer, it gives very satisfactory control of the humidifier.

It is possible to control the temperature of the rooms to within less than 1 degree Fahrenheit with the above equipment, but some objections have developed to the continuous air motion caused by the circulating fans and other work will be reported on later having to do with the effect on fruit of moving air. As a whole, the temperature and humidity controls are very satisfactory and more accurate than are found in the ordinary cold storage plant. In fact, when the commercial type of thermostat was used, results were not at all satisfactory for experimental work, particularly at high humidities, since the fluctuation in temperature would sometimes cause a precipitation of moisture.

CONDITIONS OF EXPERIMENT

Fruit was obtained from groves of the Experiment Station, Gainesville; Citrus Experiment Station, Lake Alfred; and Mammoth Grove, Inc., Lake Wales. Some time was consumed in transporting the fruit from grove to cold storage plant, but an effort was made to place the fruit in cold storage as soon after picking as practicable. At no time was the interval between picking and storing more than 48 hours, and for the most part it was less than 24 hours.

The fruit was stored in the experimental refrigeration plant in Gainesville, where it was held in six different storage rooms maintained at temperatures of 32°, 37½°, 42°, 48°, 54° and 58° F., respectively. Temperatures were maintained to within 1 degree of those desired. Humidity varied slightly, but was held generally between 85° and 90° except in the room held at 32° F. Here the humidity was much lower, as there was a greater tendency for the moisture to freeze out onto the refrigeration pipes.

METHODS OF ANALYSIS

Methods of analysis were the same for all samples. In each analysis six samples of six fruits each were used (*4*).

Specific gravity of the whole fruit was determined by weighing in air and under water (25° C.). The six fruits making up the sample were considered as one in taking the specific gravity. Each fruit was then peeled, cut in half and the juice extracted by means of a Witte press.

The following analyses were then made on the extracted juice:

The percent juice was taken by dividing the weight of juice by the total weight of the fruit.

Specific gravity of the juice was obtained by use of a hydrometer.

Titratable acidity was obtained by titrating duplicate 10 cc. samples of the juice with N/10 sodium hydroxide, using phenolphthalein as the indicator.

pH was determined with the quinhydrone electrode.

Sugar was determined by the Shaffer-Hartman method, using the cuprous titrations for all samples. Free reducing, hydrolyzable and total sugars were determined and all calculated as dextrose, using the Munson-Walker tables.

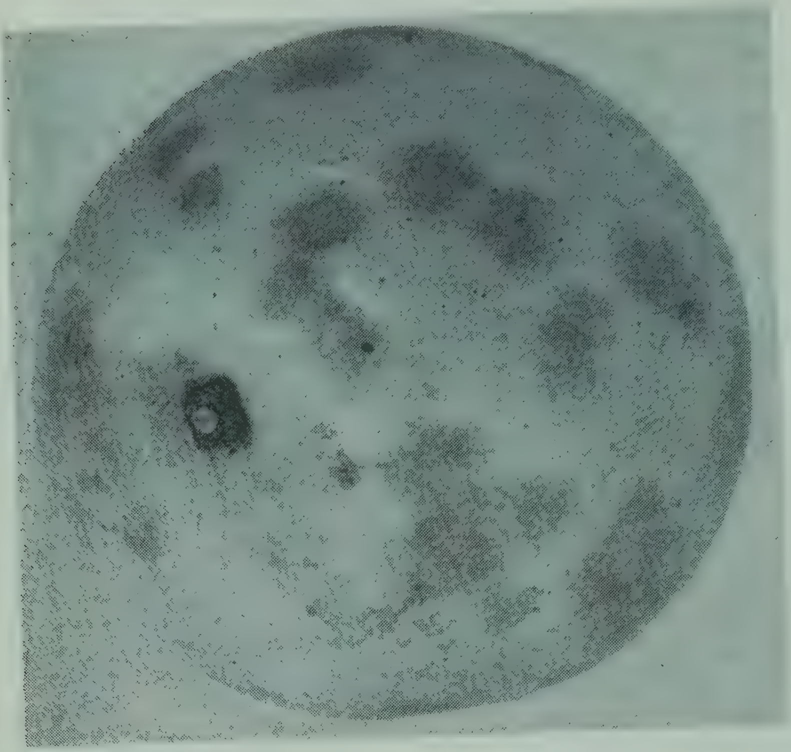

Fig. 5.—Typical "storage pitting" on grapefruit.

EXPLANATION OF TERMS

The purpose of placing citrus fruits in cold storage is to prevent development of decay, retard respiration and delay deterioration, in order to lengthen the life of the fruit. Fungus diseases that affect the fruit can best be controlled by storage at the lowest possible temperatures without freezing. There are certain physiological disturbances, however, that arise at these low tempera-

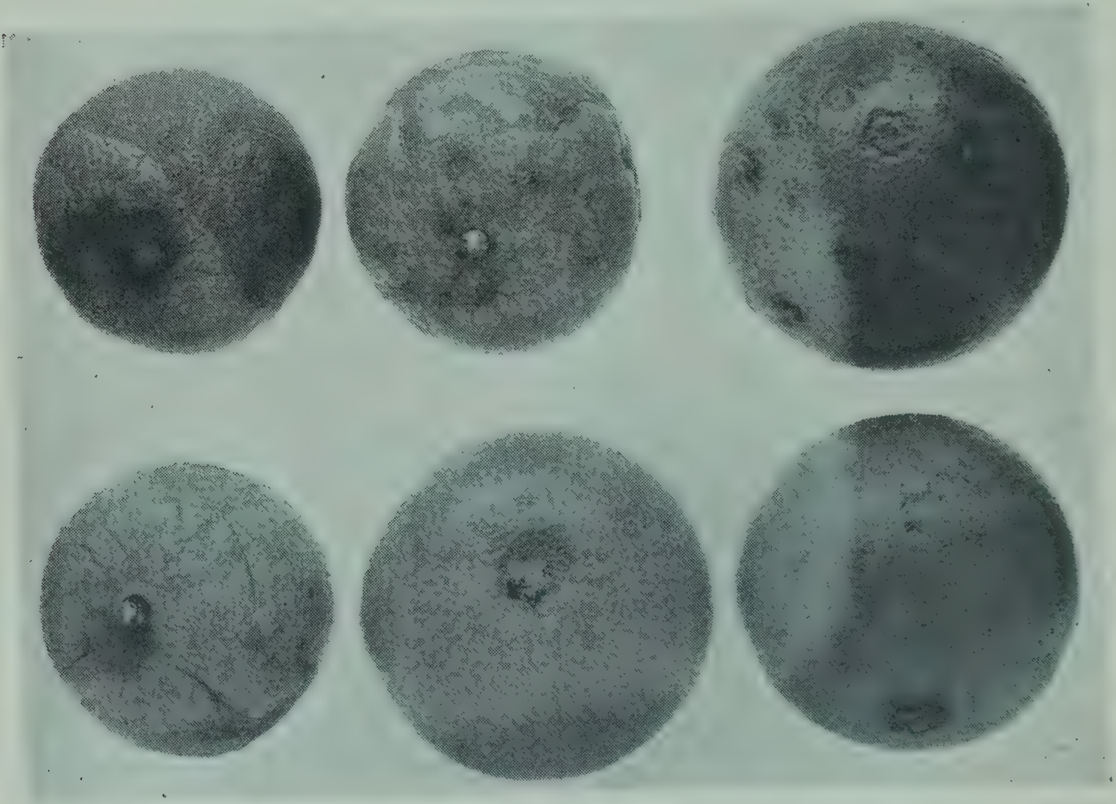

Fig. 6.—Typical forms of "storage pitting" on oranges. Type at top left often is called "scald". Pitting around the button often is called "stem-end drying".

tures, chief among which are pitting, scald, soggy and internal breakdown.

Pitting is one of the most serious problems encountered in holding citrus fruit in cold storage and is one of the most difficult to control. The sunken spots are confined to the flavedo (outside layer of rind containing the oil vesicles) and are formed by a breakdown of this tissue. Pitting first appears as small slightly sunken spots, which increase in size and may coalesce, forming irregular-shaped patches. With age, or upon exposure to warmer temperatures, the spots gradually turn brown. Besides detracting from appearance, keeping quality and market-

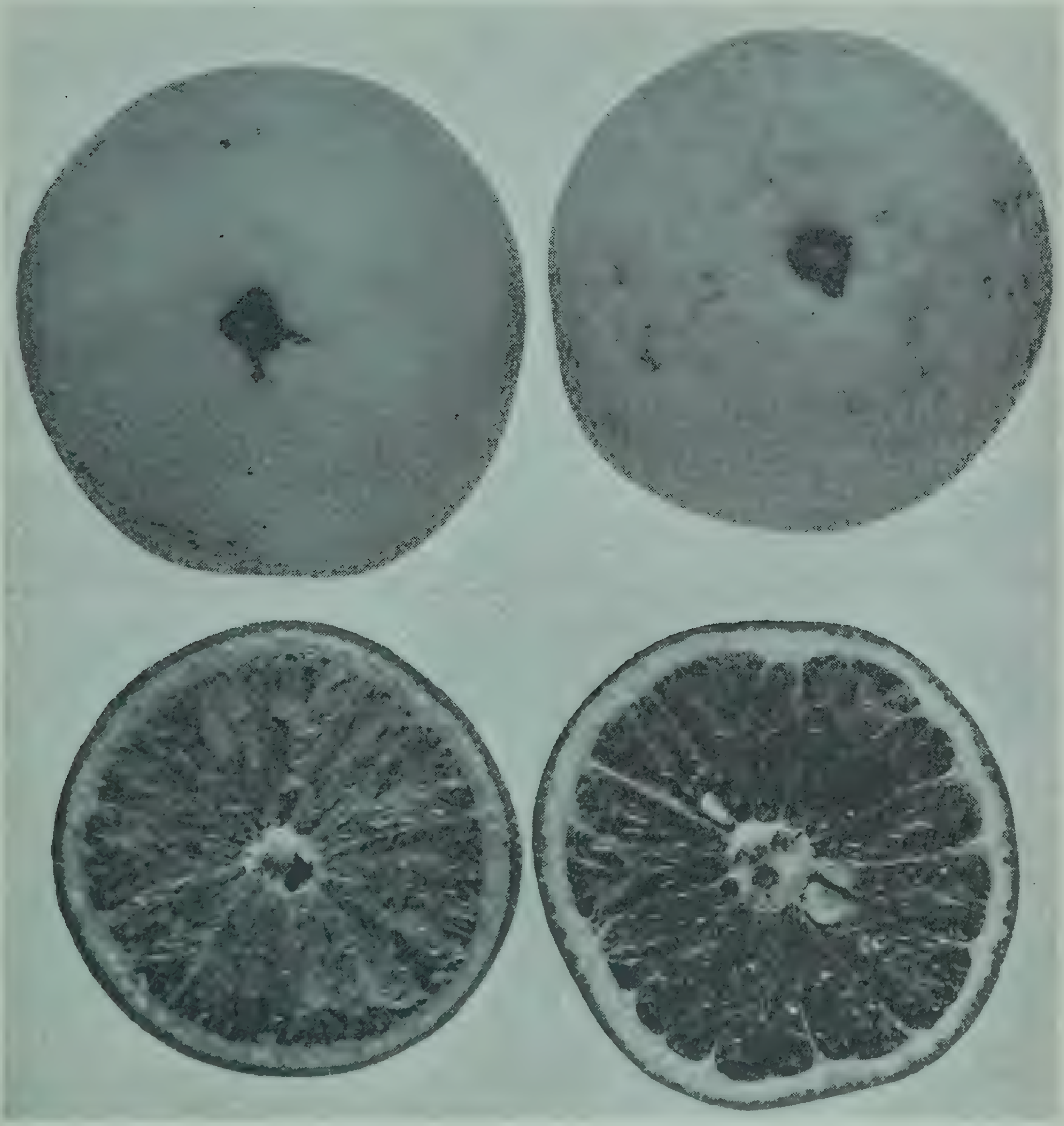

Fig. 7.—Silver Cluster grapefruit after two months' storage at 32° F., showing soggy breakdown (left) both whole and in cross-section. Normal fruit with pitted rind on right. Note soggy appearance of rind and pulp in comparison with normal fruit.

ability of citrus fruits, the pitted spots serve as an entrance for decay-producing fungi. Pitting has no direct effect on the quality or taste of the fruit (Fig. 5).

Scald is also due to a physiological disorder or breakdown of the rind tissue of cold stored fruit. The injury to the rind is somewhat similar to mild pitting, but is more superficial.

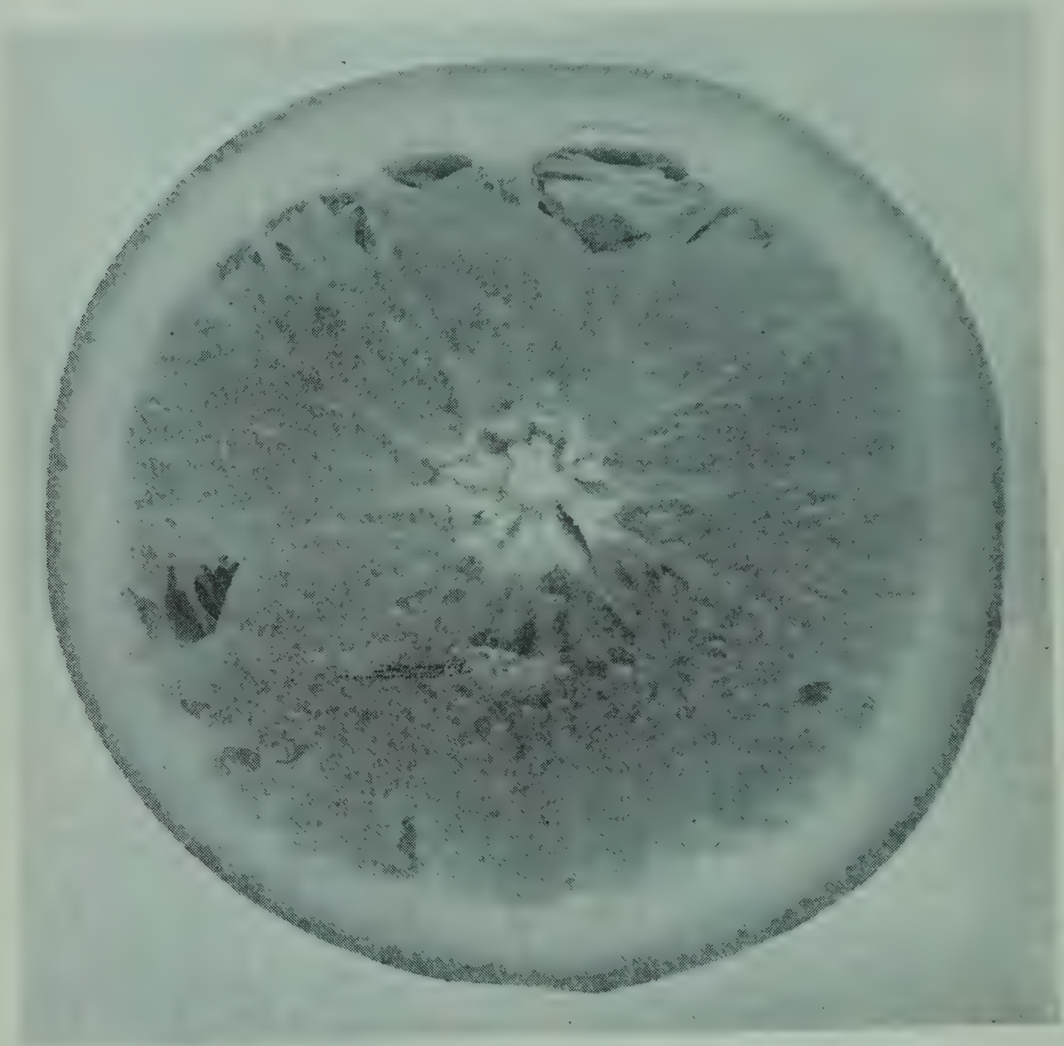

Fig. 8.—Cross-section of Marsh Seedless grapefruit after three months' storage at 37½° F., showing internal breakdown due to pressure in packing.

Scald may often appear on fruits which are also pitted and in many respects the two troubles appear to be related. Scald also renders the fruit unmarketable from the standpoint of appearance and the physiological breakdown of the rind lowers the resistance of the fruit to decay (Fig. 6).

Soggy breakdown, or watery breakdown, is another physiological disorder encountered in the cold storage of citrus fruits. The rind at first appears to be water-soaked and the color slightly paled. The inner rind (albedo) becomes soft and soggy, taking on a yellowish color, and later is thoroughly water-soaked. In severe cases, the locular walls (rag), central axis and pulp become soggy. Oil from the oil glands penetrates through all other tissues, giving a resinous, oily odor and taste to the fruit. It spreads rapidly and appears to be closely related to the respiratory and transpiratory activities (Fig. 7).

Internal Breakdown and Bruising.—A high percentage of internal breakdown results from bulge-pack bruising. Fruits are injured in pressing down the lids of packing boxes when the fruit is bulge-packed. Bruised fruit is more subject to decay than that not bruised, owing to the ease of entrance of fungus organisms. Even though no secondary infection should occur, a physiological breakdown occurs in the bruised portion, with excessive drying out of the juice sacs (Fig. 8).

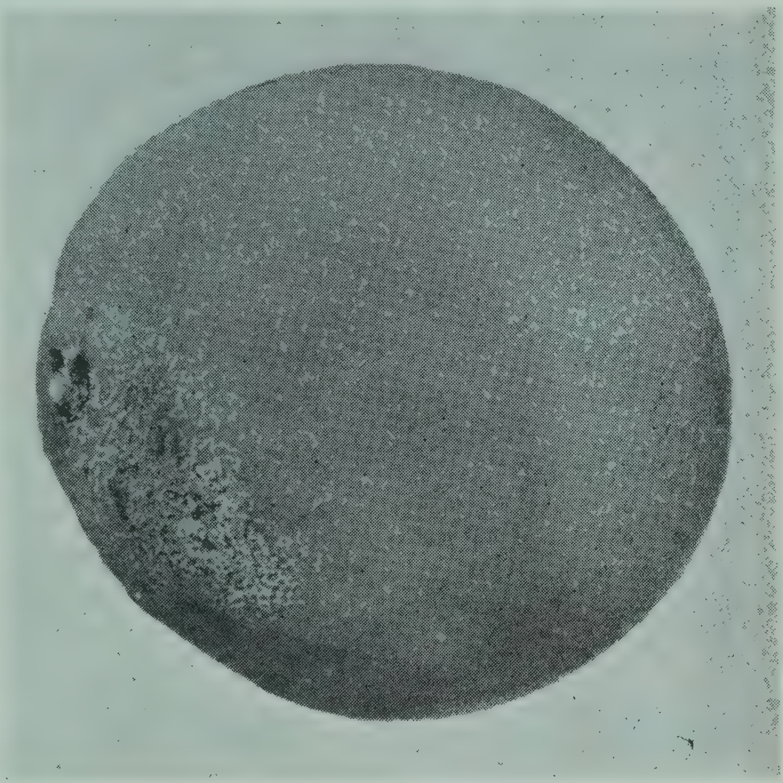

Fig. 9.—Stem-end rot fungus (*Phomopsis citri*) on Valencia orange at 42° F.

Stem-end rot is the term applied to fruit showing at first an almost imperceptible discoloration around the button with a slight abnormal degree of pliability, soon followed by a leathery, pliable condition and a drab to brown, translucent, watery discoloration of the surface of the rind. There has been no effort made to distinguish between stem-end rot caused by *Diplodia natalensis* and *Phomopsis citri*, as the rots caused by them cannot with certainty be distinguished without pure culture tests. (Fig. 9.)

Blue mold is the term applied to the disease of those citrus fruits showing either blue-contact mold (*Penicillium italicum*) or the common green mold (*Penicillium digitatum*). It is a soft, watery decay which starts as a discoloration on the surface of the fruit and later involves the entire fruit, becoming a soft, shrunken mass covered with a layer of blue or green powdery spores.

Nesting is a term applied to a condition occurring in packed boxes of fruit during storage. The organism will spread from one infected fruit to fruits in contact with it, thus forming a group or nest of infected fruits within the box. It usually occurs in unwrapped fruit and in fruit wrapped in wrappers which will allow the passage of mycelium and spores and which break down and tear when moistened. This can easily be prevented by using wrappers that will stand up under cold storage conditions (*15*).

EXPERIMENTAL RESULTS WITH ORANGES

The storage data of one mid-season variety (Pineapple) and one late season variety (Valencia) are presented together with similar data for the following varieties: Magnum Bonum, Madam Vinus, Centennial and Lue Gim Gong.

PINEAPPLE ORANGES

CHANGES IN COMPOSITION DURING STORAGE

Data on changes in composition obtained from analyses of Pineapple oranges beginning January 23, when they were placed in storage, and continuing at regular intervals throughout the storage period, are summarized in Table 1.

Besides the decrease shown in total weight, volume and percent juice, very slight changes occur in any of the other constituents. Changes in specific gravity of the whole fruit, specific gravity of the juice, percent acid (titratable), pH, and free reducing, hydrolyzable and total sugars, are all within the limit of error of analyses or variation in content among individual fruits.

Changes in taste and flavor were much more pronounced than those in composition. It appears that methods of analysis used were not fine enough to show differences in composition of fruit held at different temperatures which were clearly brought out by taste, quality and appearance. Storage tastes and odors were detected in the fruit held at higher temperatures long before that held at lower temperatures, yet the composition

TABLE 1.—CHANGES IN COMPOSITION OF PINEAPPLE ORANGES DURING STORAGE AT VARIOUS TEMPERATURES.

Date of Analysis	Weight of Fruit (gms.)	Specific Gravity of Fruit	Volume of Juice (cc.)	Specific Gravity of Juice	Percent Juice	Percent Acid (citric)	pH	Percent Sugars (Calculated as Dextrose)		
								Free Reducing	Hydrolyzable	Total
Stored at Room Temperature (1-23-32)										
1-23-32*	167.5	0.9950	92.8	1.051	58.04	0.839	3.92	4.21	3.47	7.68
2-11-32	143.8	1.0170	81.5	1.052	59.80	0.767	4.01	4.55	3.14	7.69
Stored at 32° F. (1-23-32)										
1-23-32*	167.5	0.9950	92.8	1.051	58.04	0.839	3.92	4.21	3.47	7.68
3- 4-32	150.5	0.9932	81.7	1.048	56.84	0.758	4.04	3.83	2.91	6.74
3-21-32	152.1	1.0005	77.3	1.052	53.42	0.803	4.32	4.31	3.85	8.16
4- 4-32	144.6	1.0070	69.5	1.056	50.71	0.806	4.01	4.57	3.79	8.36
4-19-32	155.9	0.9880	76.1	1.049	50.94	0.668	4.18	3.84	3.16	7.00
Stored at 37½° F. (1-23-32)										
1-23-32*	167.5	0.9950	92.8	1.051	58.04	0.839	3.92	4.21	3.47	7.68
2-25-32	180.1	0.9721	98.8	1.045	57.01	0.753	4.04	3.61	2.87	6.48
3-21-32	155.1	0.9851	76.4	1.053	51.87	0.810	4.34	4.19	3.56	7.75
4- 4-32	156.8	0.9815	77.8	1.053	52.20	0.855	3.98	4.26	3.63	7.89
4-19-32	168.1	0.9571	75.5	1.051	47.18	0.740	4.15	3.76	3.74	7.50
Stored at 42° F. (1-23-32)										
1-23-32*	167.5	0.9950	92.8	1.051	58.04	0.839	3.92	4.21	3.47	7.68
3- 5-32	155.7	0.9830	74.8	1.052	50.56	0.894	4.05	4.09	3.37	7.46
3-22-32	144.6	0.9848	72.3	1.051	52.65	0.817	4.35	4.03	3.05	7.08
4- 5-32	145.4	0.9836	64.7	1.056	46.96	0.878	4.04	4.70	3.51	8.21
4-19-32	157.3	0.9644	68.0	1.052	45.69	0.817	4.04	4.03	2.84	6.87

*Check (Average of 30 fruit). (All other values are averages of 36 fruit).

TABLE 1.—CHANGES IN COMPOSITION OF PINEAPPLE ORANGES DURING STORAGE AT VARIOUS TEMPERATURES—*Continued.*

Date of Analysis	Weight of Fruit (gms.)	Specific Gravity of Fruit	Volume of Juice (cc.)	Specific Gravity of Juice	Percent Juice	Percent Acid (citric)	pH	Percent Sugars (Calculated as Dextrose)		
								Free Reducing	Hydrolyzable	Total
Stored at 48° F. (1-23-32)										
1-23-32*	167.5	0.9950	92.8	1.051	58.04	0.839	3.92	4.21	3.47	7.68
3- 8-32	152.1	0.9836	75.0	1.053	51.87	0.786	4.18	4.15	4.13	8.28
3-22-32	155.9	0.9779	80.4	1.049	54.08	0.772	4.40	3.68	3.04	6.72
4- 5-32	145.5	0.9711	64.8	1.050	46.75	0.762	4.19	3.83	2.46	6.29
4-19-32	163.7	0.9611	69.6	1.047	44.50	0.750	4.13	3.56	3.67	7.23
Stored at 54° F. (1-23-32)										
1-23-32*	167.5	0.9950	92.8	1.051	58.04	0.839	3.92	4.21	3.47	7.68
3- 7-32	146.6	0.9914	67.3	1.050	48.30	0.866	3.97	3.81	3.45	7.35
3-22-32	143.4	0.9952	77.9	1.053	56.43	0.846	4.34	4.55	3.29	7.84
4-21-32	145.7	0.9930	71.8	1.052	51.92	0.873	3.97	4.13	3.21	7.34
Stored at 58° F. (1-23-32)										
1-23-32*	167.5	0.9950	92.8	1.051	58.04	0.839	3.92	4.21	3.47	7.68
3- 8-32	164.0	0.9749	77.8	1.047	49.70	0.730	4.30	3.40	3.98	7.38
3-32-32	151.5	0.9691	77.2	1.046	53.25	0.666	4.53	3.31	3.31	6.62
4- 5-32	145.7	0.9932	67.5	1.050	48.65	0.718	4.23	4.02	2.98	7.00

*Check (Average of 30 fruit). (All other values are averages of 36 fruit).

values show no decided differences. The figures are of value because they show that the change in composition during storage is slow and that the acid and sugar content changes only slightly over a long period of time.

KEEPING QUALITY DURING COLD STORAGE

Loss in Weight.—Twenty-five fruits were set aside on shelves in each of seven rooms held at different temperatures, all having the same humidity, and weighed individually at regular intervals to determine loss in weight. Table 2 gives the percent loss in weight after one month, six weeks, two months and three months in storage at the seven different storage temperatures.

TABLE 2.—Total Percentage Loss in Weight of Pineapple Oranges Stored at Various Temperatures. (Average of 25 Fruits.)

Temperature	Percentage loss in weight after			
	1 month	6 weeks	2 months	3 months
32° F.	5.3	7.7	9.9	14.1
37½° F.	4.3	6.9	8.9	13.8
42° F.	6.2	9.3	11.8	16.9
48° F.	5.1	7.9	10.4	15.4
54° F.	10.4	16.1	21.1	......
60° F.	10.8	16.0	20.0	......
Room (70-80° F.)	18.0	25.0	......	......

Most of this loss in weight was due to loss in moisture but some is lost by respiration. The figures of the table bring out very clearly that the amount of weight lost is dependent on temperature and length of storage period. Fruit at room temperature lost three times as much weight as did that held at 32° F. With an increase in storage temperature, there was an increase in loss in weight.

Quality of the fruit was chiefly affected by loss in weight. Appearance also was greatly affected by this factor, as shriveling always accompanied excessive drying. Not only the rind was affected, but the pulp also dried out. Beginning first with drying at the stem end, the juice sacs lost moisture, becoming ricey and tasteless.

TABLE 3.—EFFECT OF TEMPERATURE ON MARKETABILITY AND THE KEEPING QUALITY OF PINEAPPLE ORANGES IN COLD STORAGE.

Date	Time in Storage (wks.)	Stored at 32° F.				Stored at 37½° F.				Stored at 42° F.			
		Pitting*	% Decay		Percent Marketable Fruit	Pitting*	% Decay		Percent Marketable Fruit	Pitting*	% Decay		Market-Percent able Fruit
			Stem End Rot	Other Decays			Stem End Rot	Other Decays			Stem End Rot	Other Decays	
1-23-32	0	—	0.0	0.0	100.0	—	0.0	0.0	100.0	—	0.0	0.0	100.0
3- 6-32	6	—	0.0	0.0	100.0	—	0.0	0.0	100.0	—	0.0	0.0	100.0
3-21-32	8	—	0.0	0.0	100.0	—	0.0	0.0	100.0	—	3.8	0.9	95.3
4- 4-32	10	+—	4.0	0.0	96.0	—	5.2	0.0	94.8	—	14.2	2.5	83.3
4-18-32	12	+—	9.2	0.0	90.8	+—	10.5	1.5	88.0	—	15.0	10.5	74.5
		Stored at 48° F.				Stored at 54° F.				Stored at 60° F.			
1-23-32	0	—	0.0	0.0	100.0	—	0.0	0.0	100.0	—	0.0	0.0	100.0
3- 6-32	6	—	3.0	0.8	96.2	—	5.0	2.0	93.0	—	10.0	5.5	84.5
3-21-32	8	—	8.0	4.0	88.0	—	10.2	5.3	84.5	—	18.2	16.4	65.4
4- 4-32	10	—	16.0	7.3	76.7	—	18.4	8.9	72.7	—	25.3	20.2	44.5
4-18-32	12	—	21.5	15.2	63.3	—	25.0	20.5	54.5	—	49.7	28.0	22.3

*Relative amounts of pitting are indicated as follows: (—) indicates absence of pitting; (+—), (+), etc., indicate relatively greater degrees of pitting.

Rating: (—), no pits; (+—), 1 to 15 pits; (+), 15 to 30 pits.

Storage Pitting and Decay.—Table 3 is a tabulation of the amount and severity of storage pitting, percent decay and percent marketable fruit throughout the storage period at six different storage temperatures. Relative amounts of pittings are indicated as follows: (—) indicates absence of pitting; (+—), (+), etc., indicate relatively greater degrees of pitting.

Pitting was very slight at the two lowest temperatures of 32° and 37½° F. and negligible at temperatures of 42° F. and higher. At no time during the storage period was pitting severe enough, even at the lower temperatures, to cause any fruit to become unmarketable.

From figures of Table 3 it appears that the amount of decay is dependent upon temperature. The colder the temperature, the less decay during storage. Stem-end rot was by far the most common of the various decays appearing in the stored fruit. It is interesting to note that, after two months' storage, 100 percent of the fruit stored at 32° F. and 37½° F. was still in marketable condition. Even after three months of storage at these two temperatures, around 90 percent of the fruit was still marketable.

KEEPING QUALITY AFTER REMOVAL FROM COLD STORAGE

Table 4 gives data on length of time the fruit remained marketable after removal from cold storage. Percent marketable fruit at the time of removal and after six, eight and 12 weeks of storage is given for five, 10 and 15 days after removal from storage. Two boxes of fruit were removed from each temperature (150 fruit to the box) and observed as to length of time the fruit remained marketable packed in the commercial boxes. When the fruit decayed or took on a dry, shriveled appearance, it was judged unmarketable. Comparisons were made of taste and general appearance of the fruit with that on the market at that time in order to arrive at a more accurate determination of its marketability at any one time.

Figures for percent marketable fruit at the time of removal show that more fruit was marketable at all times from the lower temperatures than from the higher ones. After two months' storage at 32° and 37½° F. there was still 100 percent of the fruit marketable, while only 84 to 88 percent of that held at the higher temperatures was marketable at this time.

Fruit held at 37½° F. remained marketable longest and had the best quality after removal from storage. The longer fruit

TABLE 4.—EFFECT OF TEMPERATURE AND LENGTH OF STORAGE PERIOD ON KEEPING QUALITY OF MATURE PINEAPPLE ORANGES AFTER REMOVAL FROM COLD STORAGE.

Storage Temperature	Date Stored	Date Removed	Time in Storage (Weeks)	% Marketable at Time of Removal	% Marketable*		
					After 5 Days	After 10 Days	After 15 Days
32° F.**	1-23-32	2-20-32	6	100.0	90.3	85.0	80.4
	“	3-21-32	8	100.0	91.0	84.6	78.2
	“	4-18-32	12	90.8	85.0	83.8	78.0
37½° F.	“	2-20-32	6	100.0	99.0	90.6	87.2
	“	3-21-32	8	100.0	95.6	90.3	89.0
	“	4-18-32	12	88.0	96.3	86.4	82.5
42° F.	“	2-20-32	6	100.0	92.3	90.4	80.6
	“	3-21-32	8	95.3	87.4	85.2	78.9
	“	4-18-32	12	74.5	82.5	80.4	75.2
48° F.	“	2-20-32	6	96.2	91.8	83.6	82.1
	“	3-21-32	8	88.0	90.2	82.1	77.3
	“	4-18-32	12	63.3	85.2	80.4	72.1
54° F.	“	2-20-32	6	93.0	86.8	81.9	71.0
	“	3-21-32	8	84.5	80.0	69.3	65.7
	“	4-18-32	12	54.5	85.9	70.0	67.3
Check (Room Temp., 70°-80° F.)	“	—	0	—	100.0	93.0	85.0

*Percent of those removed (300 fruits from each temperature removed).

**Unmarketability at this temperature mostly due to soggy breakdown rather than decay.

was kept in storage, the shorter the time it remained marketable when removed. That held in storage six weeks remained marketable much longer than that held 12 weeks.

Loss after removal from storage was due mostly to decay. The loss after five, 10 and 15 days for cold-stored fruit was not much heavier than for that not cold-stored (check fruit).

Nesting was bad in the boxes removed from storage. Contact molds spread rapidly from one infected fruit to surrounding good fruit. This condition was remedied by carefully examining the fruit every few days and removing that which was decayed.

From the reaction of fruit during cold storage, it would seem that best storage temperature for unwrapped Pineapple oranges was 32° F., but, considering also the reaction after removal from storage, the temperature of 37½° F. was best for the storage of unwrapped, untreated Pineapple oranges. Fruit from cold storage of 32° F. became either soggy or decayed shortly after removal, while that removed from 42° F. or higher was more shriveled and dried and took on more pronounced storage flavors and tastes than did those removed from 37½° F.

VALENCIA ORANGES

The effect of maturity of the fruit on changes taking place and keeping quality during storage of Valencia oranges, as well as temperature of the storage rooms, was studied. Lots were placed in storage at intervals of four weeks, beginning on February 29 and ending June 1. A complete analysis, consisting of total weight and specific gravity of the whole fruit and specific gravity, volume, titratable acidity, pH and Brix values of the juice, together with the free-reducing, hydrolyzable and total sugars, was made on the fruit of each lot every two weeks until the termination of the experiment. Also, observations and counts were made every two weeks as to percent loss by decay, percent pitted and percent marketable fruit.

To correlate the changes taking place in the stored fruit with those on the tree, samples were picked at random from the tree and shipped to Gainesville every two weeks and complete analyses made immediately.

The weekly loss in weight of the fruit was determined by placing 25 fruits (random selection) of each storage lot on shelves in each of the four storage rooms and weighing at weekly intervals during the time they remained marketable.

TABLE 5.—CHANGES IN COMPOSITION OF VALENCIA ORANGES DURING PROCESS OF MATURING ON THE TREE*.

Lot No.	Maturity	Date Picked	Date of Analysis	Wght. of Fruit (gms.)	Specific Gravity of Fruit	Volume of Juice (cc.)	Specific Gravity of Juice	Percent Juice	Percent Acid (Citric)	pH	Percent Sugars (Calculated as Dextrose)		
											Free Reducing	Hydrolyzable	Total
1-V	Under normal maturity	2-29-32	3- 2-32	187.4	.9970	109	1.049	59.62	1.010	3.66	4.06	3.20	7.26
2-V	Under normal maturity	3-15-32	3-17-32	192.9	.9839	112	1.051	60.59	1.104	3.69	4.27	3.50	7.77
3-V	Mature	3-31-32	4- 2-32	190.4	.9886	103	1.052	56.74	1.026	3.66	4.70	3.72	8.42
4-V	Mature	4-15-32	4-16-32	196.0	.9760	107	1.054	57.64	0.965	3.76	4.74	3.44	8.18
5-V	Slightly overmature	5- 2-32	5- 5-32	199.3	.9906	105	1.053	55.45	0.973	3.75	4.53	4.10	8.63
6-V	Over normal maturity	5-17-32	5-18-32	198.7	.9913	113	1.055	59.79	0.880	3.84	4.57	4.12	8.69
7-V	Over normal maturity	6- 1-32	6- 2-32	198.7	.9929	108	1.055	57.24	0.821	3.87	4.94	4.25	9.19

*All values are averages of 36 fruits.

CHANGES IN COMPOSITION OF FRUIT ON THE TREE

Table 5 contains data obtained from analyses of the fruit directly from the tree, beginning with March 2, when the Valencia oranges were coloring but were still immature as to eating quality, and continuing at two-week intervals until the fruit was over-mature and past the optimum time of harvesting for best eating quality. All figures in the table are averages of the analyses of 36 fruits.

There is an increase in total weight of the fruit with maturity. There seems to be very little change in specific gravity of the whole fruit and a very slight increase in specific gravity of the juice with increasing maturity.

Figures for percent juice show a slight decrease with maturity but are too variable to be used as a measure of maturity, being within the range of variability for individual fruits.

The percent acid (titratable acidity) decreases from 1.010 for the immature fruit to 0.82 for the over-mature fruit. The pH values increase with maturity, thus indicating a decrease in effective acidity.

There was an increase in total solids.

Figures for percent sugar indicated an increase in free-reducing, hydrolyzable and total sugars. Total sugars increased from 7.26 percent for the immature fruit to 9.19 percent for the over-mature fruit analyzed three months later. This accounts for a major portion of the increase in total solids.

CHANGES IN COMPOSITION OF THE FRUIT IN STORAGE

Effect of Maturity.—In Tables 6, 7, 8 and 9 are given the values for various physical and chemical characteristics of the fruit analyzed every two weeks from storage temperatures of 32°, 37½°, 42° and 58° F., respectively. Each table is made up in four parts, each part giving the results of analyses of fruit stored at a stage in its maturity. Fruit below normal maturity was placed in storage March 1, mature fruit April 1 and May 1, and fruit above normal maturity June 1.

A study of the values summarized in these tables reveals many interesting relations between the physical and chemical characteristics of the fruit of varying maturity held at different temperatures.

Considering first the data of Table 6, which gives the analytical values of the fruit held at 32° F., it will be noted that with but few exceptions trends of change in various characteristics

TABLE 6.—CHANGES IN COMPOSITION OF VALENCIA ORANGES PLACED IN STORAGE AT DIFFERENT STAGES OF MATURITY AND HELD AT 32 DEGREES F.

Date of Analysis	Weight of Fruit (gms.)	Specific Gravity of Fruit	Volume of Juice (cc.)	Specific Gravity of Juice	Percent Juice	Percent Acid (Citric)	pH	Percent Sugars (Calculated as Dextrose) Free Reducing	Hydro-lyzable	Total
Fruit Under Normal Maturity. Stored 3-3-32										
3- 3-32*	187.4	.9970	109	1.049	59.62	1.010	3.66	4.06	3.20	7.26
3-19-32	200.9	.9884	116	1.049	61.54	1.053	3.86	3.86	3.29	7.15
4- 2-32	189.0	.9934	104	1.052	57.60	1.068	3.61	4.41	2.80	7.21
4-15-32	185.6	.9993	108	1.053	59.33	1.034	3.73	4.15	3.91	8.06
5- 3-32	195.4	.9771	105	1.051	56.16	1.036	3.71	4.04	4.44	8.48
5-17-32	176.0	.9958	88	1.053	51.89	1.068	3.62	4.31	4.66	8.97
5-31-32	211.6	.9745	110	1.049	54.53	0.876	3.84	3.85	4.30	8.15
6-14-32	204.6	.9786	108	1.050	55.51	0.915	3.69	3.86	4.09	7.95
6-29-32	183.9	.9826	92	1.053	52.40	0.906	3.75	4.35	4.55	8.90
7-14-32	192.3	.9738	100	1.051	54.62	0.897	3.67	3.79	4.65	8.44
7-30-32	186.1	.9651	89	1.051	48.91	0.915	3.66	4.01	4.11	8.12
8-15-32	179.9	.9620	85	1.053	49.72	0.850	3.73	5.51	4 29	8.80
9- 1-32	195.6	.9406	88	1.050	47.37	0.853	3.69	3.25	5.60	9.85
9-17-32	160.1	.9623	76	1.055	49.93	0.928	3.71	4.32	4.54	8.86
Fruit of Normal Maturity. Stored 4-2-32										
4- 2-32*	190.4	.9886	103	1.052	56.74	1.026	3.66	4.70	3.72	8.42
4-15-32	194.4	.9842	111	1.051	59.83	0.971	3.71	4.32	4.11	8.43
5- 3-32	200.5	.9817	113	1.051	59.43	0.979	3.74	4.36	4.13	8.49
5-17-32	186.0	.9947	94	1.056	54.02	0.994	3.72	4.88	4.49	9.37
5-31-32	209.8	.9810	106	1.051	53.02	0.924	3.82	4.03	4.33	8.36
6-14-32	211.6	.9808	113	1.051	56.18	0.852	3.72	4.37	4.46	8.83
6-30-32	178.1	.9779	97	1.053	56.97	0.887	3.71	4.43	4.46	8.89
7-15-32	191.9	.9650	98	1.049	54.21	0.852	3.74	3.85	3.93	7.78
7-30-32	183.1	.9553	92	1.052	52.57	0.807	3.76	4.07	4.52	8.59
8-15-32	182.4	.9604	87	1.055	50.44	0.839	3.82	4.29	4.94	9.23
9- 1-32	183.3	.9228	87	1.052	49.81	0.811	3.77	4.38	4.58	8.96
9-17-32	178.9	.9417	89	1.052	52.28	0.831	3.79	4.72	4.59	9.31
10- 3-32	173.9	.9063	86	1.053	50.86	0.782	3.83	4.38	4.46	8.84

*All values are averages of 36 fruits.

TABLE 6.—CHANGES IN COMPOSITION OF VALENCIA ORANGES PLACED IN STORAGE AT DIFFERENT STAGES OF MATURITY AND HELD AT 32 DEGREES F.—*Continued.*

Date of Analysis	Weight of Fruit (gms.)	Specific Gravity of Fruit	Volume of Juice (cc.)	Specific Gravity of Juice	Percent Juice	Percent Acid (Citric)	pH	Percent Sugars (Calculated as Dextrose)		
								Free Reducing	Hydro-lyzable	Total
Fruit Slightly Above Normal Maturity. Stored 5-5-32										
5- 5-32*	199.3	.9906	105	1.053	55.45	0.973	3.75	4.53	4.10	8.63
5-17-32	187.0	.9963	94	1.058	53.29	0.915	3.80	4.94	4.78	9.72
5-31-32	204.2	.9931	108	1.056	55.68	0.898	3.84	4.63	4.32	8.95
6-14-32	201.0	.9844	111	1.052	58.14	0.846	3.81	4.12	4.44	8.56
6-30-32	193.4	.9925	104	1.055	56.90	0.860	3.78	4.89	4.59	9.48
7-15-32	211.5	.9789	110	1.052	54.69	0.796	3.89	4.39	4.67	9.06
7-30-32	200.9	.9749	104	1.053	54.58	0.775	3.85	4.23	4.52	8.75
8-15-32	186.2	.9841	94	1.057	53.16	0.868	3.78	4.75	4.95	9.70
9- 1-32	197.7	.9770	97	1.057	52.12	0.785	3.98	4.35	5.55	9.90
9-17-32	191.2	.9687	99	1.055	54.30	0.842	3.82	4.44	4.99	9.43
10- 3-32	183.8	.9656	92	1.057	51.92	0.785	3.88	4.75	5.04	9.79
10-17-32	181.6	.9648	92	1.058	53.29	0.782	3.95	4.55	5.22	9.77
Fruit Above Normal Maturity. Stored 6-2-32										
6- 2-32*	198.7	.9929	108	1.055	57.24	0.821	3.87	4.94	4.25	9.19
6-14-32	209.0	.9882	107	1.055	53.79	0.797	3.84	4.52	4.64	9.16
6-30-32	207.5	.9934	115	1.056	58.52	0.794	3.85	4.69	4.93	9.62
7-15-32	207.9	.9839	110	1.054	55.70	0.713	4.00	4.46	4.94	9.40
7-30-32	197.8	.9951	110	1.056	59.05	0.701	3.93	4.28	4.83	9.11
8-15-32	195.5	1.0003	102	1.058	55.28	0.760	3.96	4.86	5.30	10.16
9- 1-32	215.0	.9650	107	1.053	52.39	0.712	3.99	4.31	4.71	9.02
9-16-32	220.9	.9387	114	1.049	54.15	0.687	3.93	4.52	5.42	9.94
10- 4-32	215.8	.9775	119	1.054	57.95	0.686	3.92	4.25	4.89	9.14
10-17-32	182.5	.9768	91	1.059	52.53	0.749	3.94	4.99	5.26	10.25

*All values are averages of 36 fruits.

TABLE 7.—CHANGES IN COMPOSITION OF VALENCIA ORANGES PLACED IN STORAGE AT DIFFERENT STAGES OF MATURITY AND HELD AT 37½ DEGREES F.

Date of Analysis	Weight of Fruit (gms.)	Specific Gravity of Fruit	Volume of Juice (cc.)	Specific Gravity of Juice	Percent Juice	Percent Acid (Citric)	pH	Percent Sugars (Calculated as Dextrose)		
								Free Reducing	Hydro-lyzable	Total
Fruit Stored Under Normal Maturity. Stored 3-3-32										
3- 3-32*	187.4	.9970	109	1.049	59.62	1.010	3.66	4.06	3.20	7.26
3-19-32	202.4	.9837	113	1.049	58.77	0.952	3.90	4.12	3.40	7.53
4- 2-32	183.6	.9959	97	1.054	55.74	1.030	3.66	4.32	0.80	5.12
4-14-32	200.4	.9841	111	1.051	60.19	0.961	3.74	4.04	3.91	7.95
5- 2-32	188.3	.9806	95	1.053	52.70	1.054	3.86	3.93	4.70	8.63
5-16-32	209.9	.9689	106	1.050	52.84	0.945	3.69	3.96	4.81	8.77
5-31-32	205.1	.9699	102	1.052	52.41	0.911	3.69	3.97	4.45	8.42
6-14-32	199.9	.9616	97	1.050	50.75	0.913	3.73	3.89	4.39	8.28
6-29-32	200.9	.9525	91	1.050	47.49	0.831	3.73	3.77	4.90	8.67
7-14-32	185.7	.9423	89	1.053	50.27	0.878	3.76	3.77	4.44	9.21
7-30-32	178.3	.9355	84	1.052	49.32	0.831	3.77	3.42	5.12	8.54
8-15-32	183.1	.9228	87	1.052	49.70	0.821	3.80	3.77	5.11	8.88
8-31-32	186.1	.9087	86	1.050	48.25	0.750	3.89	3.56	5.42	8.98
9-15-32	141.4	.9034	66	1.056	49.07	0.734	3.89	3.97	5.77	9.74
Fruit of Normal Maturity. Stored 4-1-32										
4- 2-32*	190.4	.9886	103	1.052	56.74	1.026	3.66	4.70	3.72	8.42
4-14-32	209.7	.9837	118	1.049	58.89	0.967	3.73	4.16	3.73	7.89
5- 2-32	195.9	.9823	104	1.051	55.95	1.019	3.67	4.43	4.42	8.85
5-16-32	213.8	.9751	107	1.052	52.43	0.938	3.75	4.27	4.93	9.20
5-31-32	211.8	.9766	107	1.054	53.18	0.905	3.78	4.41	4.20	8.61
6-14-32	206.4	.9621	109	1.050	54.70	0.893	3.72	4.15	4.45	8.60
6-29-32	190.2	.9570	87	1.054	48.25	0.872	3.75	4.43	5.00	9.43
7-14-32	221.2	.9449	112	1.050	53.20	0.800	3.82	3.74	4.23	7.97
7-30-32	228.9	.9270	110	1.049	50.23	0.761	3.82	3.25	4.12	7.37
8-15-32	214.1	.9304	102	1.053	49.95	0.785	3.87	3.72	5.12	8.84
8-31-32	180.1	.9245	86	1.055	50.51	0.754	3.96	3.91	4.69	8.60
9-15-32	190.8	.9090	92	1.056	50.93	0.728	3.95	3.95	5.58	9.53

*All values are averages of 36 fruits.

TABLE 7.—CHANGES IN COMPOSITION OF VALENCIA ORANGES PLACED IN STORAGE AT DIFFERENT STAGES OF MATURITY AND HELD AT 37½ DEGREES F.—*Continued.*

Date of Analysis	Weight of Fruit (gms.)	Specific Gravity of Fruit	Volume of Juice (cc.)	Specific Gravity of Juice	Percent Juice	Percent Acid (Citric)	pH	Percent Sugars (Calculated as Dextrose)		
								Free Reducing	Hydro-lyzable	Total
Fruit Slightly Above Normal Maturity. Stored 5-5-32										
5- 5-32*	199.3	.9906	105	1.053	55.45	0.973	3.75	4.53	4.10	8.63
5-16-32	202.5	.9920	106	1.054	55.11	0.931	3.73	4.31	4.37	8.68
5-31-32	203.3	.9850	107	1.052	55.46	0.867	3.84	4.26	4.26	8.52
6-14-32	209.9	.9819	115	1.052	57.74	0.845	3.77	4.15	4.34	8.49
6-29-32	213.4	.9766	108	1.053	53.43	0.847	3.73	4.44	4.69	9.13
7-14-32	206.6	.9566	105	1.051	53.33	0.963	3.90	3.78	4.66	8.44
7-30-32	193.1	.9683	98	1.054	53.24	0.764	3.85	4.25	4.61	8.86
8-15-32	182.3	.9595	87	1.058	50.29	0.839	3.88	4.58	5.19	9.77
8-31-32	211.2	.9433	106	1.054	52.64	0.734	3.93	4.09	5.19	9.28
9-15-32	189.2	.9421	85	1.055	47.07	0.734	3.96	3.91	5.53	9.44
10- 3-32	169.1	.9226	81	1.057	50.38	0.762	3.93	4.09	5.34	9.43
Fruit Above Normal Maturity. Stored 6-2-32										
6- 2-32*	198.7	.9929	108	1.055	57.24	0.821	3.87	4.94	4.25	9.19
6-14-32	179.7	1.0013	99	1.059	58.21	0.855	3.79	5.21	4.74	9.95
6-29-32	174.8	.9885	89	1.057	53.50	0.779	3.81	4.71	4.89	9.60
7-14-32	180.1	.9901	106	1.058	62.43	0.837	3.85	4.84	5.13	9.97
7-30-32	180.5	.9861	95	1.057	55.72	0.837	3.79	4.97	5.01	9.98
8-15-32	173.6	.9935	88	1.062	53.66	0.834	3.87	5.41	5.31	10.72
8-31-32	173.5	.9801	89	1.059	54.09	0.781	3.89	4.71	5.17	9.88
9-15-32	170.3	.9667	86	1.058	53.36	0.765	3.95	4.42	5.81	10.23
10- 3-32	160.5	.9635	79	1.063	52.07	0.816	3.93	5.16	5.53	10.69
10-17-32	163.6	.9702	79	1.062	51.36	0.781	3.96	5.17	5.88	11.05

*All values are averages of 36 fruits.

TABLE 8.—CHANGES IN COMPOSITION OF VALENCIA ORANGES PLACED IN STORAGE AT DIFFERENT STAGES OF MATURITY AND HELD AT 42 DEGREES F.

Date of Analysis	Weight of Fruit (gms.)	Specific Gravity of Fruit	Volume of Juice (cc.)	Specific Gravity of Juice	Percent Juice	Percent Acid (Citric)	pH	Percent Sugars (Calculated as Dextrose)		
								Free Reducing	Hydro-lyzable	Total
				Fruit Stored Under Normal Maturity. Stored 3-3-32						
3- 3-32*	187.4	.9970	109	1.049	59.62	1.010	3.66	4.06	3.20	7.26
3-19-32	175.4	.9971	98	1.053	58.39	1.124	3.85	4.47	4.04	8.51
4- 2-32	175.3	.9870	94	1.053	56.25	1.068	3.62	4.60	3.26	7.86
4-16-32	187.2	.9825	97	1.053	54.58	1.100	3.64	4.33	4.11	8.44
5- 3-32	193.0	.9921	105	1.049	57.05	0.987	3.70	3.90	4.82	8.72
5-17-32	189.9	.9775	92	1.054	50.96	1.036	3.67	4.34	4.88	9.22
6- 1-32	191.6	.9692	101	1.050	55.46	1.023	3.57	4.09	4.35	8.44
6-15-32	191.4	.9571	95	1.051	51.42	0.942	3.72	4.25	4.25	8.50
6-30-32	179.2	.9508	88	1.053	51.62	0.907	3.75	3.98	4.96	8.94
7-15-32	173.3	.9455	80	1.053	48.37	0.923	3.79	3.96	4.35	8.31
8- 1-32	163.2	.9341	75	1.053	48.27	0.860	3.78	3.71	4.70	8.41
8-16-32	155.5	.9343	69	1.053	46.80	0.809	3.91	3.90	5.02	8.92
9- 1-32	125.6	.9446	56	1.055	47.31	0.821	3.90	4.52	3.86	8.38
				Fruit of Normal Maturity. Stored 4-2-32						
4- 2-32*	190.4	.9886	103	1.052	56.74	1.026	3.66	4.70	3.72	8.42
4-16-32	179.3	.9983	97	1.056	57.34	1.012	3.72	4.95	2.98	7.93
5- 3-32	177.9	.9863	93	1.053	54.77	1.029	3.74	4.43	4.44	8.87
5-17-32	186.8	.9838	85	1.056	48.07	0.995	3.74	4.56	4.79	9.35
6- 1-32	214.4	.9646	112	1.054	54.87	0.934	3.75	4.38	4.28	8.66
6-15-32	203.8	.9636	106	1.052	54.81	0.984	3.70	4.24	4.72	8.96
6-30-32	194.0	.9615	97	1.054	52.40	0.865	3.77	4.43	4.77	9.20
7-15-32	188.1	.9625	93	1.055	52.00	0.851	3.85	3.96	4.79	8.75
8- 1-32	179.8	.9600	87	1.056	50.79	0.779	3.89	4.13	4.94	9.07
8-16-32	185.8	.9323	90	1.053	50.77	0.789	3.90	4.13	4.90	9.03
9- 1-32	183.4	.9231	80	1.053	46.15	0.756	4.00	4.05	5.26	9.31
9-16-32	171.1	.9162	83	1.054	51.31	0.707	3.90	4.09	5.26	9.35

*All values are averages of 36 fruits.

TABLE 8.—CHANGES IN COMPOSITION OF VALENCIA ORANGES PLACED IN STORAGE AT DIFFERENT STAGES OF MATURITY AND HELD AT 42 DEGREES F.—*Continued.*

Date of Analysis	Weight of Fruit (gms.)	Specific Gravity of Fruit	Volume of Juice (cc.)	Specific Gravity of Juice	Percent Juice	Percent Acid (Citric)	pH	Percent Sugars (Calculated as Dextrose)		
								Free Reducing	Hydro-lyzable	Total
Fruit Slightly Above Normal Maturity. Stored 5-5-32										
5- 5-32*	199.3	.9906	105	1.053	55.45	0.973	3.75	4.53	4.10	8.63
5-17-32	203.9	.9905	104	1.055	53.75	0.955	3.74	4.78	4.24	9.02
6- 1-32	211.2	.9744	112	1.052	55.84	0.846	3.78	4.00	4.47	8.47
6-15-32	203.6	.9795	110	1.056	56.70	0.931	3.77	5.54	3.78	9.32
6-30-32	235.2	.9527	120	1.052	53.69	0.777	3.87	4.32	4.31	8.63
7-16-32	204.8	.9598	105	1.055	54.06	0.900	3.75	4.20	4.44	8.64
8- 1-32	195.1	.9501	90	1.056	48.43	0.816	3.86	4.31	5.26	9.57
8-16-32	183.3	.9602	89	1.056	50.97	0.847	3.83	4.73	4.94	9.67
9- 2-32	195.9	.9371	90	1.054	47.85	0.797	3.91	4.39	4.93	9.32
9-16-32	215.2	.9218	103	1.053	50.43	0.731	3.83	4.15	5.11	9.26
10- 4-32	215.3	.8857	101	1.053	49.29	0.656	4.03	4.11	5.08	9.19
10-17-32	188.4	.9295	91	1.056	51.14	0.686	3.98	4.42	5.24	9.66
Fruit Above Normal Maturity. Stored 6-2-32										
6- 2-32*	198.7	.9929	108	1.055	57.24	0.821	3.87	4.94	4.25	9.19
6-15-32	236.3	.9840	132	1.055	58.75	0.782	3.90	4.46	4.67	9.13
6-30-32	233.7	.9747	122	1.054	55.14	0.790	3.84	4.50	4.30	8.80
7-16-32	226.4	.9729	119	1.055	55.43	0.772	3.85	4.55	4.20	8.75
8- 1-32	218.0	.9722	115	1.055	55.43	0.742	3.92	4.68	4.88	9.56
8-16-32	217.9	.9813	111	1.058	53.90	0.764	3.91	4.94	5.02	9.96
9- 2-32	220.1	.9694	115	1.056	54.94	0.720	3.98	4.76	5.08	9.84
9-17-32	191.6	.9939	103	1.057	56.95	0.729	3.96	4.12	4.10	8.22
10- 4-32	194.6	.9375	97	1.058	52.76	0.669	4.06	4.50	5.36	9.86

*All values are averages of 36 fruits.

TABLE 9.—CHANGES IN COMPOSITION OF VALENCIA ORANGES PLACED IN STORAGE AT DIFFERENT STAGES OF MATURITY AND HELD AT 58 DEGREES F.

Date of Analysis	Weight of Fruit (gms.)	Specific Gravity of Fruit	Volume of Juice (cc.)	Specific Gravity of Juice	Percent Juice	Percent Acid (Citric)	pH	Percent Sugars (Calculated as Dextrose)		
								Free Reducing	Hydro-lyzable	Total
Fruit Stored Under Normal Maturity. Stored 3-3-32										
3- 3-32*	187.4	.9970	109	1.049	59.62	1.010	3.66	4.06	3.20	7.26
3-19-32	196.7	.9956	110	1.050	58.49	1.102	3.88	4.12	3.06	7.18
4- 2-32	189.3	.9943	111	1.051	61.79	1.058	3.66	4.23	2.97	7.20
4-16-32	184.7	.9927	111	1.051	58.45	1.004	3.73	4.43	3.51	7.94
5- 5-32	200.3	.9879	103	1.052	54.97	1.035	3.69	4.00	4.48	8.48
5-19-32	196.8	.9795	103	1.049	54.74	0.924	3.77	3.78	4.08	7.86
6- 2-32	180.6	.9738	97	1.049	56.35	0.874	3.62	4.09	3.69	7.78
6-16-32	186.7	.9826	96	1.048	53.61	0.792	3.91	3.91	4.04	7.95
7- 1-32	163.3	.9741	76	1.054	56.92	0.908	3.82	4.87	3.91	8.78
Fruit of Normal Maturity. Stored 4-2-32										
4- 2-32*	190.4	.9886	103	1.052	56.74	1.026	3.66	4.70	3.72	8.42
4-16-32	190.0	.9904	102	1.054	56.35	0.992	3.71	4.58	4.32	8.90
5- 5-32	199.3	.9872	105	1.055	55.25	0.944	3.77	4.94	4.77	9.71
5-18-32	186.2	.9937	99	1.054	56.23	0.908	3.79	4.89	4.41	9.30
6- 2-32	192.0	.9849	109	1.053	59.49	0.860	3.72	4.44	4.50	8.94
6-16-32	190.9	.9846	107	1.053	57.12	0.879	3.88	4.47	4.42	8.89
7- 1-32	194.3	.9761	104	1.051	56.25	0.803	3.87	4.30	4.34	8.64
7-16-32	155.6	.9856	81	1.055	54.76	0.783	3.94	4.49	4.35	8.84
8- 3-32	149.0	.9564	74	1.058	52.35	0.790	3.99	4.57	4.68	9.25

*All values are averages of 36 fruits.

TABLE 9.—Changes in Composition of Valencia Oranges Placed in Storage at Different Stages of Maturity and Held at 58 Degrees F.—*Continued.*

Date of Analysis	Weight of Fruit (gms.)	Specific Gravity of Fruit	Volume of Juice (cc.)	Specific Gravity of Juice	Percent Juice	Percent Acid (Citric)	pH	Percent Sugars (Calculated as Dextrose)		
								Free Reducing	Hydro-lyzable	Total
Fruit Slightly Above Normal Maturity. Stored 5-2-32										
5- 2-32*	199.3	.9906	105	1.053	55.45	0.973	3.75	4.53	4.10	8.63
5-19-32	198.9	.9828	102	1.055	54.02	0.819	3.84	4.83	4.61	9.44
6- 2-32	232.2	.9712	132	1.051	59.81	0.836	3.73	4.24	3.65	7.89
6-16-32	242.1	.9705	137	1.051	59.39	0.752	3.91	4.54	3.75	8.29
7- 1-32	202.0	.9711	105	1.054	54.47	0.724	3.97	4.76	4.27	9.03
7-16-32	210.3	.9715	105	1.055	52.18	0.730	3.95	4.05	4.80	8.85
8- 3-32	190.5	.9719	93	1.056	51.60	0.774	3.98	3.58	5.08	9.66
8-16-32	174.4	.9641	85	1.061	51.68	0.675	4.13	4.89	5.65	10.54
Fruit Above Normal Maturity. Stored 6-2-32										
6- 2-32*	198.7	.9929	108	1.055	57.24	0.821	3.87	4.94	4.25	9.19
6-16-32	195.7	.9927	108	1.057	58.47	0.902	3.82	4.98	4.37	9.34
7- 1-32	185.8	1.0004	99	1.060	56.12	0.818	3.88	4.73	4.88	9.61
7-16-32	177.3	1.0002	92	1.059	54.72	0.799	3.91	4.93	5.02	9.95
8- 3-32	155.9	1.0180	85	1.065	57.86	0.805	3.97	5.73	5.73	11.46
8-16-32	143.6	1.0110	76	1.065	56.19	0.790	4.06	5.78	5.78	11.56

*All values are averages of 36 fruits.

are in the same direction during storage as when the fruit is still on the tree, but not in the same degree. Similar to changes in the fruit while on the tree, there is an increase while in storage in specific gravity of the juice, pH values, total solids, hydrolyzable and total sugars and a decrease in the percent juice and percent acidity (titratable acidity). See Fig. 10.

Figures for free-reducing sugars are variable but show little change in either direction. These changes in stored fruits, while in the same direction as those for fruit on the tree, are much less pronounced. For example, in the case of percent acid and total sugar, in mature fruit stored slightly below normal it takes six months for the same change which takes place in three months on the tree. Likewise, four months are required for this change in total sugar and acid content in the mature stored fruit that takes place in two months on the tree, and two months for the same change in the above-normal stored fruit which occurred in one month on the tree. Thus, it is readily observed that the metabolism or life processes of the fruit are greatly retarded by storage at 32° F. The rate of metabolism or change toward maturation is retarded more than half or, in other words, the metabolic processes go on at one-half the rate of normal metabolism on the tree. Unlike the changes in the fruit while on the tree, there is a decrease in the total weight and specific gravity of the fruit during storage.

The values of the characteristics given in Tables 7, 8 and 9, representing the analyses of fruit stored at 37½°, 42° and 58° F., respectively, show the same changes as that stored at 32° F., but in different degrees. The higher the temperature, the faster the rate of change in values of the various characteristics. The figures show a definite relationship as to temperature, in that the rate of metabolism is directly related to the temperature; the colder the temperature, the lower the rate of metabolism.

From a comparison of figures given for the different lots placed in storage at various stages of maturity, it is evident that fruit stored when not quite mature had a slower metabolism than the mature and over-mature fruit. From the standpoint of metabolic changes, it is best to store slightly under-normal mature fruit, inasmuch as the slow metabolism of this fruit permits it to be held longer before storage tastes develop. There is also less loss in weight in below-normal mature fruit than in mature or over-mature fruit, as will be shown below. Cost of

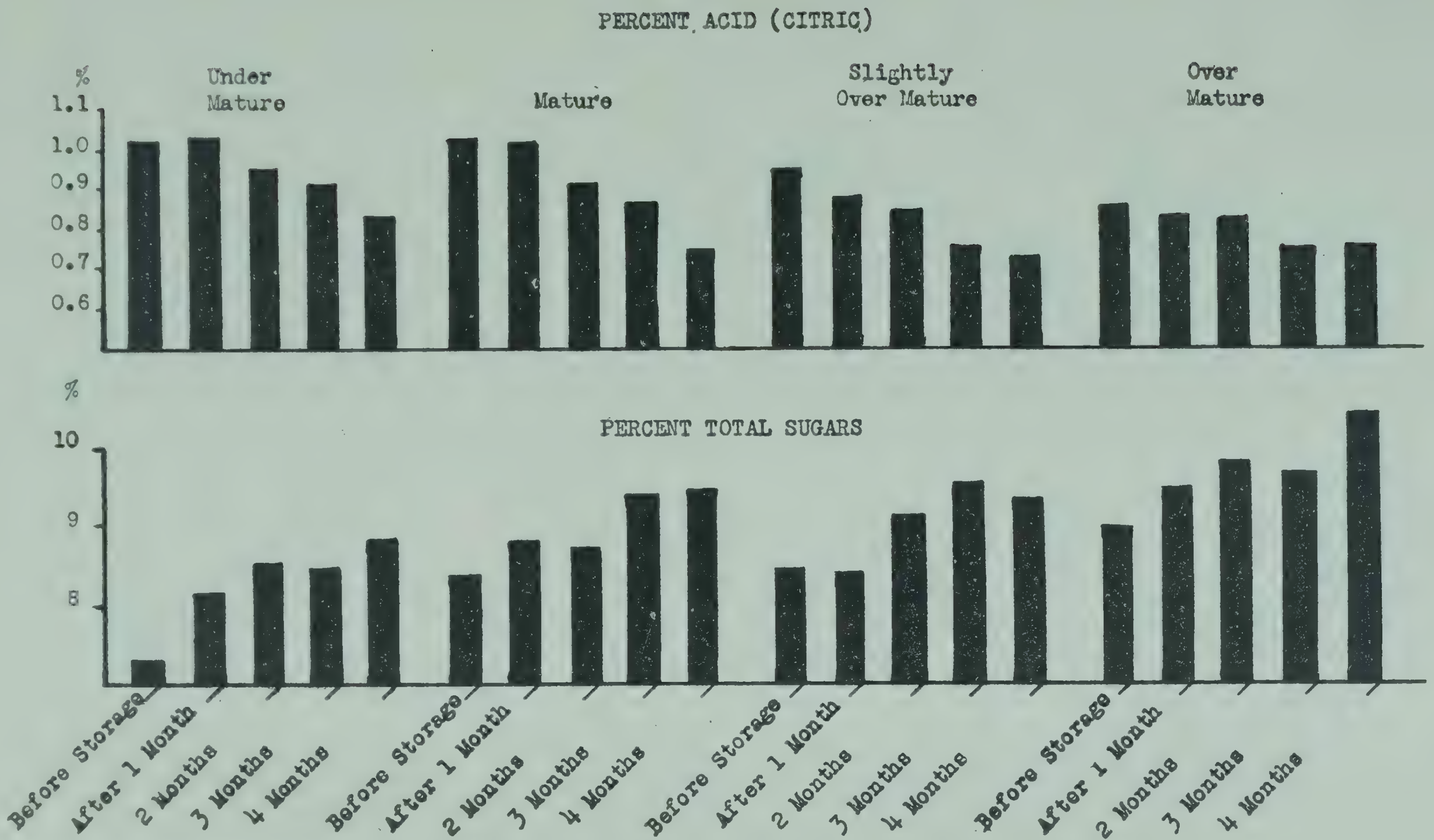

Fig. 10.—Changes in percentages of acid and sugars of Valencia oranges placed in storage (37½° F.) at various stages of maturity.

refrigeration would be less with more mature fruits, as they could be held on the tree longer, but fruit held on the tree too long or that which is over-mature does not hold up well and takes on storage tastes rapidly. The metabolism of fruit past maturity has gone beyond the point of good quality before storage takes place, and thus retarding further maturation at this stage is not beneficial or practical. Considering the cost of refrigeration, length of time that storage fruit remains marketable, and keeping quality as to deterioration and taste, the stage at which fruit should be stored for best results is when it is slightly under normal maturity. The keeping quality and marketability of this fruit are considered later in this bulletin.

Effect of Temperature.—From a study of the data of Tables 6, 7, 8 and 9, the effect of temperature is readily observed. Retarding of the life processes is effected by the cold temperatures, there being a direct relation between the rate of change and the temperature, the lower the temperature the less change in the constituents of the fruit. It takes about twice as long for the same change to occur in fruit held at 32° F. as that held at 58° F. The following statements can be made for changes in composition of the fruit at any storage temperatures, since only the degree of change in the constituents of the fruit during storage is dependent upon the temperature and maturity.

There is a decrease in total weight of fruit with time in storage. The colder the storage temperature the less the loss in weight. There is a decrease in specific gravity of the fruit but no appreciable change in the specific gravity of the juice with storage.

The figures for percent juice show a slight decrease with increase in the storage period. The percent acid (titratable acidity) (Fig. 11) decreases as length of storage period increases. This is true of the fruit at all of the storage temperatures. The pH values increase with time in storage which, of course, indicates a decrease in effective acidity. There is an increase in amount of total sugars with time in storage (Fig. 10). Variation among individual fruits accounted for the variable values obtained but, in most cases, the changes were large enough to overcome both analytical errors and variation among individual fruits.

It should be brought out here that the figures are interpreted on the wet basis and that the analyses were made on the fruits as they were taken from storage and eaten and no account was

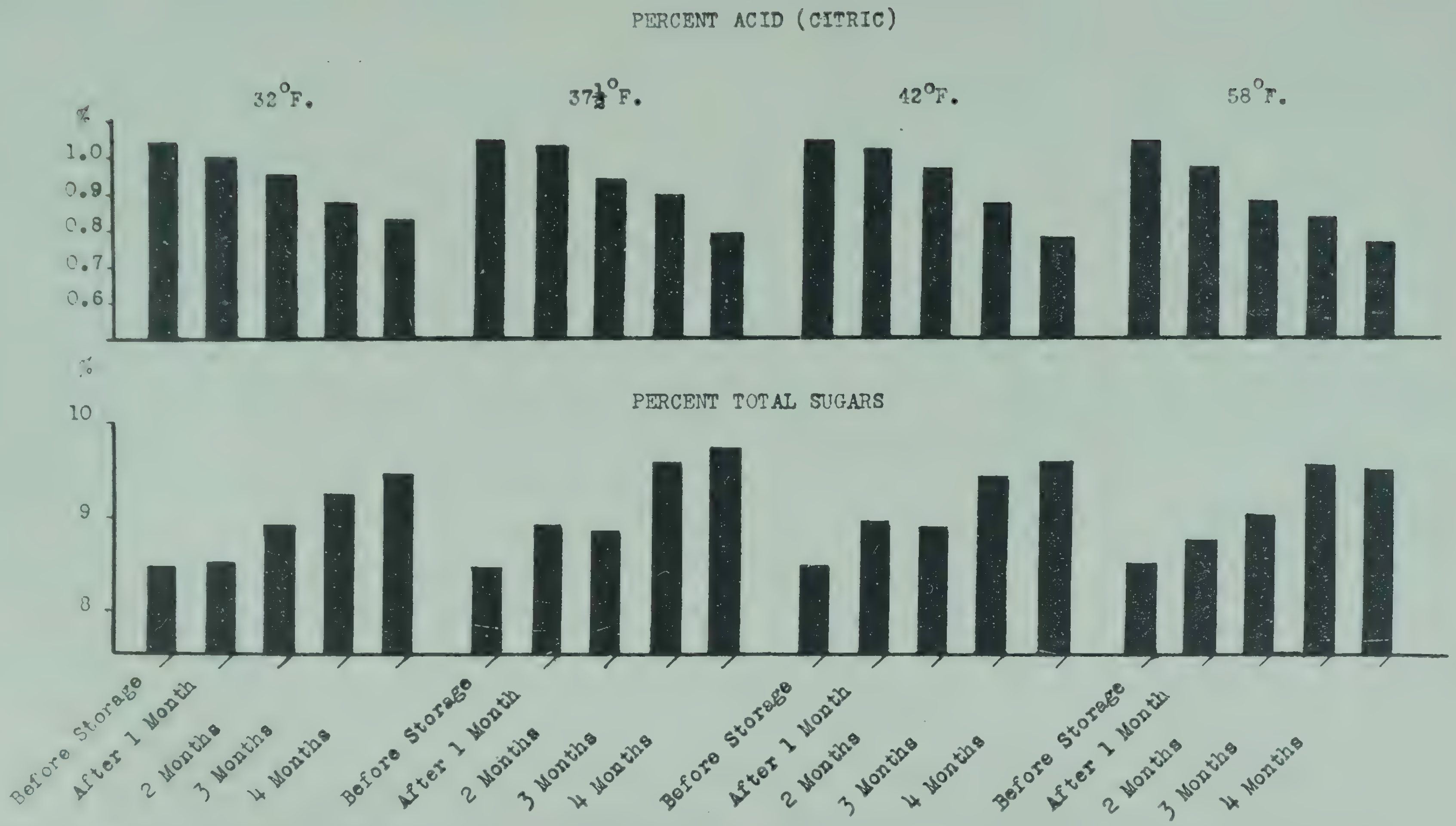

Fig. 11.—Changes in percentages of acid and sugars of mature Valencia oranges placed in storage at various temperatures (32°, 37½°, 42°, and 58° F.).

taken of the moisture lost during storage. Should the values have been calculated on the basis of percent dry weight instead of wet weight, the values would be entirely different. The percent juice decreases as moisture is lost, causing the last juice samples to be more concentrated than the ones sampled earlier.

Less change takes place in the composition of fruit stored at lower temperatures than that stored at higher temperatures. From the figures of Tables 6, 7, 8 and 9, it appears that the best storage temperatures, so far as change in composition is concerned for Valencia oranges, are the lower temperatures, as it is here that the least changes occur.

Loss in Weight.—Table 10 contains data for the loss in weight of Valencia oranges of varying stages of maturity, below normal, normal and above normal, stored at various temperatures for five months. Individual weekly weighings were recorded on 12 fruits of each stage of maturity set aside for this purpose in all of the various storage rooms. The loss in weight in grams and percent is given for each period of three weeks for storage temperatures of 32°, 37½°, 42° and 58° F.

TABLE 10.—LOSS IN WEIGHT OF VALENCIA ORANGES STORED AT VARIOUS TEMPERATURES. (AVERAGE OF 12 FRUITS.)

Time in Storage (Weeks)	32° F.		37½° F.		42° F.		58° F.	
	gms.	%	gms.	%	gms.	%	gms.	%
Under Normal Maturity:								
3	7.1	4.2	7.2	3.5	7.7	4.0	22.3	11.4
6	12.9	7.3	13.0	6.3	14.9	8.0	35.9	19.1
9	20.1	10.8	21.0	10.5	23.2	12.7	47.8	26.3
12	25.2	13.8	28.4	14.5	30.0	15.7	59.0	33.6
15	30.3	16.9	37.2	19.6	36.0	19.4	69.8	41.1
18	36.1	20.6	43.5	23.5	42.0	23.1	79.3	48.4
21	41.3	24.0	52.0	28.9	48.6	27.5	89.5	56.2
Normal Maturity:								
3	8.2	3.7	8.7	4.0	10.1	4.8	17.7	8.4
6	16.1	7.5	17.3	8.1	19.7	9.6	38.5	19.4
9	22.9	10.8	26.4	12.6	28.3	14.1	54.7	28.8
12	29.8	14.3	34.6	16.9	36.0	18.4	67.5	36.6
15	36.4	17.9	43.4	21.7	44.6	23.2	78.2	43.7
18	43.4	21.7	52.2	26.7	53.5	28.1	89.2	51.6
21	52.0	26.6	61.0	31.8	61.4	32.9	------	------
Above Normal Maturity:								
3	7.8	3.7	11.7	5.7	10.5	4.4	27.7	11.7
6	15.6	7.5	22.5	11.2	20.4	8.8	52.3	23.3
9	23.2	11.3	30.2	15.3	30.4	13.5	68.9	32.1
12	29.9	14.7	39.9	20.7	40.2	18.2	82.3	40.0
15	38.0	19.1	49.6	26.6	51.4	24.1	94.0	47.5
18	47.4	24.4	57.8	31.9	63.2	30.6	------	------
21	56.5	29.9	66.0	37.8	73.4	37.1	------	------

Comparing the temperature effect, it may be seen that as a general rule fruit of all stages of maturity lost most weight at 58° F. and least at 32° F. The higher the storage temperature the greater the loss in weight. It was found that fruit of all stages of maturity stored at 58° F. lost the most weight during the first week of storage, decreasing gradually until half as much weight is lost per week after five months' storage. On the other hand, fruit of normal and under-normal maturity held at 32° F. lost the least weight the first week and increased in amount lost per week as the storage period increased. Weekly losses in weight of fruit held at intermediate temperatures and also for that fruit which was above normal maturity when stored at 32° F. were about the same throughout the storage period. Thus, it is readily seen that high temperatures and long holding of the fruit on the tree have a curing effect on the fruit which causes a decrease in loss of weight with increased storage periods.

The average weekly loss in grams and percent was obtained over five months' storage period. The averages of the loss of weight of fruit of all the various stages of maturity were tabulated for the sake of comparison and are presented in Table 11.

TABLE 11.—AVERAGE WEEKLY LOSS IN WEIGHT IN GRAMS AND PERCENT OF VALENCIA ORANGES OF VARYING MATURITY. (STORED AT VARIOUS TEMPERATURES FOR FIVE MONTHS—AVERAGE OF 12 FRUITS.)

	32° F.		37½° F.		42° F.		58° F.	
	gms.	%	gms.	%	gms.	%	gms.	%
Under-mature	2.0	1.2	2.5	1.4	2.3	1.3	4.2	2.7
Mature	2.5	1.3	2.9	1.5	2.9	1.5	4.9	2.8
Over-mature	2.7	1.4	3.1	1.8	3.5	1.8	6.1	3.1

It will be observed from the figures of Table 11 that the loss in weight of the fruit increases as the maturity increases (maturity at the time of picking and storing). Fruit of under-normal maturity lost the least weight at all storage temperatures; the fruit of normal maturity next, and fruit of past-normal maturity the most at all storage temperatures.

The average loss per week was highest in the fruit (all stages of maturity) stored at 58° F., the warmest temperature used, and lowest in the fruit stored at 32° F., the coldest temperature used. The average percent loss per week of fruit stored at intermediate temperatures of 37½° F. and 42° F. was about the same for both temperatures and intermediate between the highest

TABLE 12.—EFFECT OF TEMPERATURE ON KEEPING QUALITY OF MATURE VALENCIA ORANGES IN STORAGE[1].

Date	Time in Storage (wks.)	Pre-storage Treatment	Stored at 32° F.				Stored at 37½° F.			
			Pitting[2]	% Decay		Percent Marketable Fruit	Pitting[2]	% Decay		Percent Marketable Fruit
				Stem End Rot	Other Fungi			Stem End Rot	Other Fungi	
4- 2-33	0	None	—	0.0	0.0	100.0	—	0.0	0.0	100.0
5- 5-33	5	None	—	0.0	0.0	100.0	—	0.0	0.0	100.0
6- 4-33	9	None	+—	0.0	0.0	100.0	+—	0.0	0.0	100.0
6-28-33	12	None	+—	0.0	0.0	100.0	+—	0.0	0.0	100.0
7-22-33	16	None	+	0.0	0.0	100.0	+	5.1	0.0	94.9
8-12-33	19	None	++	4.0	0.0	96.0	+	11.0	0.0	89.0
9- 2-33	22	None	++	9.3	0.0	90.7	++	33.1	1.7	65.2
9-26-33	25	None	++	20.7	0.0	79.3	++	40.7	5.9	53.4
			Stored at 42° F.				Stored at 58° F.			
4- 2-33	0	None	—	0.0	0.0	100.0	—	0.0	0.0	100.0
5- 5-33	5	None	—	0.0	0.0	100.0	—	9.9	4.4	85.7
6- 4-33	9	None	+—	3.8	0.6	95.6	+—	15.9	10.4	73.7
6-28-33	12	None	+—	13.3	1.9	84.8	+—	25.3	14.3	60.4
7-22-33	16	None	+	27.2	13.3	59.5	+—	39.0	16.5	44.5
8-12-33	19	None	+	42.4	15.8	41.8	+—	44.0	17.0	39.0
9- 2-33	22	None	+	46.8	19.6	33.6	*	*	*	*
9-26-33	25	None	+	48.7	21.5	29.8	*	*	*	*

[1] Six boxes stored at each temperature.

[2] Relative degrees of pitting are indicated as follows: (—) indicates absence of pitting; (+—), (+), (++), etc. indicate relatively greater degrees of pitting.

*Fruit either unmarketable or entirely decayed.

and lowest. The least moisture lost of any of the fruit was that lost by the fruit under normal maturity stored at 32° F., and the most by the fruit above normal maturity stored at 58° F. Shriveling always accompanied excessive drying out, thus the appearance was affected greatly by loss in weight. Quality of texture and taste also were affected greatly by loss in weight. The pulp lost most moisture from the stem end, causing the juice sacs to become ricey and tasteless. Shriveling of the rind was most severe at the stem end, often darkening into the appearance of a spreading type of pitting.

KEEPING QUALITY DURING COLD STORAGE

A periodical examination of the fruits from the various storage temperatures was made and the data compiled and summarized in Table 12.

Relative amounts of pitting are indicated as follows: (—) indicates absence of pitting, (+), (++), etc., indicate relatively greater degrees of pitting. The percent decay is given in percent stem-end rot and percent other fungi. The percent marketable fruit is given and includes all fruit not injured by decay, pitting, drying, shriveling, etc., or, in other words, it is the amount of good solid marketable fruit present at time of examination. The effect of temperature as shown by the figures of Table 12 upon the keeping quality of the fruit is quite pronounced. Pitting occurred to a negligible amount at all temperatures with, possibly, a slight degree more at the colder than the warmer temperatures.

The rate increase in percent decay follows closely Van't Hoff's rule of the relation of temperature to chemical reactions—that is, the rate approximately doubles for a 10-degree increase in temperature. Stem-end rot did not occur in the fruit at the colder temperatures until eight to 12 weeks' storage and then only slightly. Other types of decays were almost entirely negligible at the lower temperatures throughout the five and six months of storage. Stem-end rot occurred fairly early at the warmer temperatures, while the other decays did not show up until after eight to 12 weeks of storage.

The percent marketable fruit is in indirect relation to the temperature. The higher the temperature the lower the percent marketable fruit. The first eight to 12 weeks around 100 percent of the fruit held at 32° F. and 37½° F. was marketable. At the end of 20 weeks, between 80 and 90 percent of the fruit held at these lower temperatures was marketable. The fruit held at the higher temperatures of 42° and 58° F. had a much lower percent marketability at any one time than that stored at 32° and 37½° F. Decay was high in the fruit stored at the higher temperatures. The fruit stored at 42° and 58° F. lasted only 12 to 16 weeks before the entire lot became decayed or unmarketable.

KEEPING QUALITY AFTER REMOVAL FROM COLD STORAGE AND PLACEMENT ON SHELVES AT ROOM TEMPERATURE

Table 13 presents data taken on length of time fruit remained marketable after removal from cold storage. The percent marketable fruit at time of removal from storage after five, 10 and 20 weeks is given. The fruit was placed on shelves at ordinary room temperature (temperature of retail store—70° to 80° F.) and observed as to length of time the majority of the fruit remained marketable. When one-fourth of the fruit had decayed, or when the entire lot took on a poor and shriveled appearance, it was classed as unmarketable. Comparisons were made of the taste and general appearance of the fruit with that on the market at that time in order to arrive at a more accurate determination of its marketability at any one time.

TABLE 13.—Effect of Temperature and Length of Storage Period on Keeping Quality of Mature Valencia Oranges After Removal from Cold Storage.

Storage Temp. (F.)	Date Stored	Date Removed	Time in Storage (Wks.)	% Marketable at Time of Removal	Number Fruit Removed	Time Remaining Marketable (Days)
32	4-2-33	5- 7-33	5	100.0	25	21
"	"	6-13-33	10	100.0	25	11
"	"	8-20-33	20	87.3	25	7
37½	"	5- 7-33	5	100.0	25	24
"	"	6-13-33	10	99.5	25	23
"	"	8-20-33	20	64.7	25	7
42	"	5- 7-33	5	100.0	25	17
"	"	6-13-33	10	91.0	25	17
"	"	8-20-33	20	36.2	25	6
58	"	5- 7-33	5	93.2	25	7
"	"	6-13-33	10	77.1	25	6

The fruit from 37½° F. remained marketable longest and in best condition when removed to room temperature. The longer the fruit was kept in storage, the shorter the time it remained marketable when removed. That held in storage five weeks remained marketable from a few days to one week out of storage.

Figures for the percent marketable fruit at time of removal show that more fruit was marketable at any one time at the lower temperatures. It should be pointed out, however, that Valencia oranges kept best in cold storage at 32° F., but when removed from storage did not remain marketable as long as that held at 37½° F. The fruit from 37½° F. was marketable for a longer time and in better condition than that stored at 32°, 42° or 58° F. when removed from storage. Thus, it would seem that the best temperature for storing unwrapped, untreated Valencia oranges is around 37½° F., with temperatures below this figure preferable to temperatures above. Fig. 12 shows typical Valencia oranges after four months' storage at 32°, 37½°, 42°, 48°, 54° and 58° F.

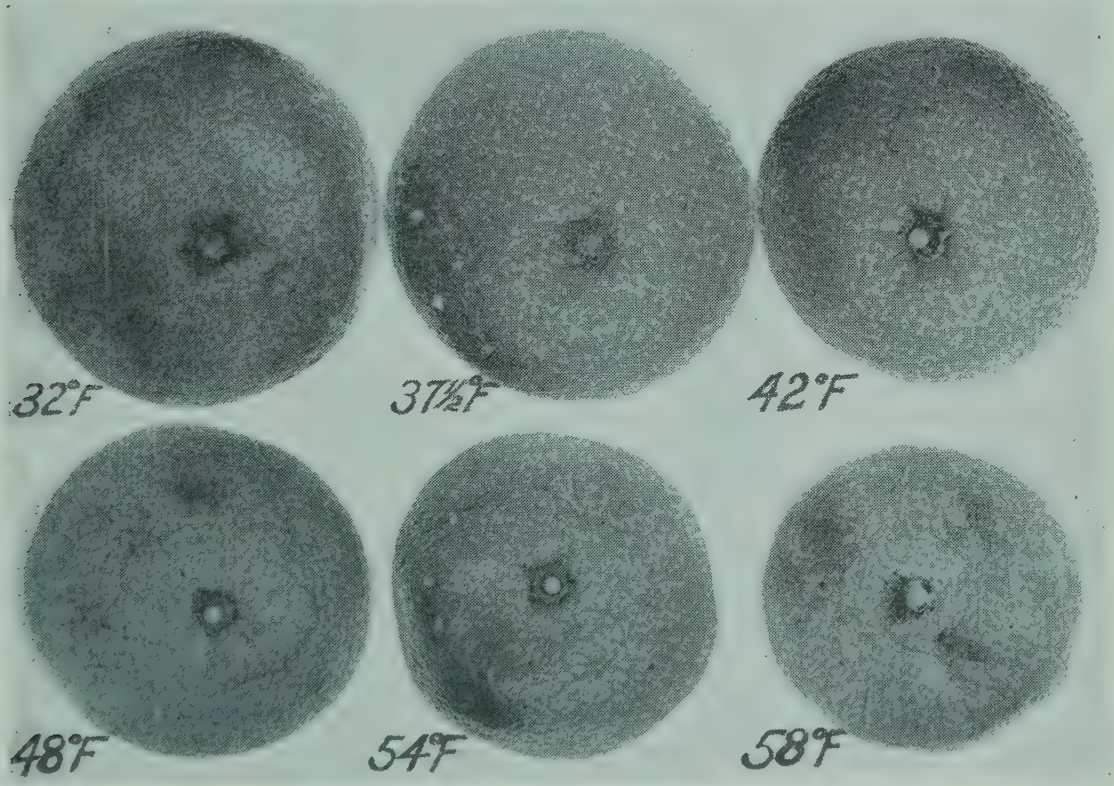

Fig. 12.—Typical Valencia oranges stored for four months unwrapped at various temperatures.

KEEPING QUALITY OF FRUIT IN COMMERCIALLY PACKED BOXES AFTER REMOVAL FROM COLD STORAGE TO ROOM TEMPERATURE

Effect of length of storage period and temperature on keeping quality of unwrapped, untreated, commercially packed Valencia oranges after removal from cold storage to room temperature is shown in Table 14.

TABLE 14.—EFFECT OF LENGTH OF STORAGE PERIOD AND TEMPERATURE ON KEEPING QUALITY OF MATURE VALENCIA ORANGES (UNWRAPPED) AFTER REMOVAL FROM COLD STORAGE TO ROOM TEMPERATURE*.

Date of Storage	Fruit Maturity	Storage Temperature	Time in Storage Mths.	After 4 Days				After 8 Days				After 12 Days			
				% Blue Mold	% Stem End Rot	% Stem End Drying	% Marketable	% Blue Mold	% Stem End Rot	% Stem End Drying	% Marketable	% Blue Mold	% Stem End Rot	% Stem End Drying	% Marketable
5-2-33	Mature	Room Temp.	Check	—	—	—	—	—	—	—	—	1.60	8.00	4.80	85.60
5-2-33	Mature	42° F.	1	0.0	0.0	2.86	97.14	3.81	5.71	9.52	80.95	3.81	14.29	28.57	53.33
5-2-33	Mature	42° F.	2	1.25	21.25	10.00	67.50	3.75	33.75	25.00	37.50	5.00	36.25	30.00	28.75
5-2-33	Mature	42° F.	3	3.33	16.67	21.67	58.33	6.67	31.67	35.00	26.67	8.33	33.33	35.00	23.33
5-2-33	Mature	42° F.	4	0.00	44.44	11.11	44.44	0.00	44.44	18.51	37.03	0.00	51.85	33.33	14.81
5-2-33	Mature	37½ °F.	1	0.89	0.00	0.89	98.21	2.68	4.46	7.14	85.71	2.68	11.61	29.46	56.25
5-2-33	Mature	37½ °F.	2	2.86	0.00	5.71	91.43	4.76	20.95	20.95	53.33	9.52	31.43	21.90	37.14
5-2-33	Mature	37½ °F.	3	4.65	3.49	24.42	67.44	8.14	20.93	38.37	32.56	8.14	29.07	45.35	17.44
5-2-33	Mature	37½ °F.	4	8.97	30.77	12.82	47.44	10.26	48.72	19.23	21.80	10.26	50.00	26.92	12.82

				After 16 Days				After 20 Days			
5-2-33	Mature	Room Temp.	Check	1.60	10.40	8.80	79.20	1.60	15.20	23.20	60.00
5-2-33	Mature	42° F.	1	3.81	21.90	36.19	38.10	3.81	25.71	41.90	28.57
5-2-33	Mature	42° F.	2	5.00	37.50	31.25	26.25	5.00	37.50	32.50	25.00
5-2-33	Mature	42° F.	3	8.33	35.00	41.67	15.00	—	—	—	—
5-2-33	Mature	42° F.	4	—	—	—	—	—	—	—	—
5-2-33	Mature	37½ °F.	1	2.68	16.07	44.64	36.61	3.57	16.07	50.89	29.46
5-2-33	Mature	37½ °F.	2	9.52	32.38	23.81	34.29	9.52	34.29	25.71	30.48
5-2-33	Mature	37½ °F.	3	8.14	30.23	46.51	15.12	—	—	—	—
5-2-33	Mature	37½ °F.	4	10.26	50.00	29.49	10.26	10.26	50.00	29.49	10.26

*One box of each maturity and of each wrapper was taken out of storage each month—thus the percentage figures are based on percent per box, The fruit was stored at 37½° F. and 42° F. and room temperature, packed 176 and 200 per box. Every four days the fruit was examined in the check boxes (those held at room temperature) and the percentage decay determined as well as percent marketable fruit. After holding in cold storage at the above temperatures for one, two, three, and four months, one box was taken out of storage and placed at room temperature. This fruit was then examined and observed every four days and percentages of decay and of marketable fruit were determined. Percentages of blue mold, stem-end rot and stem-end drying are given separately. Fruit with stem-end drying was perhaps marketable as second grade fruit, as the drying was not over one-fourth of an inch from the stem end, but the majority of the dried fruit was wrinkled and slightly discolored on the outside. Only fruit which would sell as first grade fruit was termed marketable.

Fruit stored at 37½° F. held up longer after removal from storage than did that held at lower or higher temperatures. This was found to be true of fruit placed on shelves after removal from storage. The longer the fruit was held in storage the faster it deteriorated after removal from storage. After four days from storage fruit held one month at 37½° F. was still 98 percent marketable, but that held for four months at 37½° F. was only 47 percent marketable. Stem-end rot caused more decay by far than blue mold. These two decays were the only ones detected. Those fruits which dried at the stem end were called unmarketable but were still in fair condition as far as eating quality was concerned, but the outside appearance would have placed it as second grade fruit. This drying out of the stem end was easily remedied by the use of wrappers (*15*).

Stored fruit should be utilized shortly after removal from storage, as percentage loss by decay and drying was high after several days. The results also point toward the fact that it would not be very economical to store fruit in this manner for long periods without surface treatments or wrappers (*15*). The loss from decay and loss in weight (drying out) were much higher than in wrapped or surface-treated fruit. Stem-end rot was by far the largest factor in the deterioration of the fruit, both during storage and after removal from storage.

TABLE 15.—CHANGES IN COMPOSITION OF SILVER CLUSTER GRAPEFRUIT STORED AT VARIOUS TEMPERATURES.

Date of Analyses	Specific Gravity of Fruit	Weight of Fruit (gms.)	% Juice	Specific Gravity of Juice	% Acid (Citric)	pH	% Sugars (as Dextrose)		
							Free Reducing	Hydro-lyzable	Total
Stored at Room Temperature (70-80° F.)									
12-17-32	.8576	508.6	58.4	1.044	2.0	3.34	3.1	1.6	4.7 (check)
12-30-32	.8694	487.4	58.1	1.044	2.0	3.22	3.3	1.7	5.0
1-15-33	.8701	475.5	60.4	1.044	1.9	3.20	2.9	1.8	4.7
2- 3-33	.8786	471.3	55.7	1.046	1.9	3.50	3.4	2.2	5.6
Stored at 58° F.									
12-17-32	.8576	508.6	58.4	1.044	2.0	3.34	3.1	1.6	4.7 (check)
12-29-32	.8706	522.5	58.4	1.044	1.8	3.25	3.6	2.1	5.7
1-18-33	.8893	507.1	59.9	1.049	2.0	3.26	3.9	1.7	5.6
2- 4-33	.8689	572.7	54.3	1.045	1.8	3.31	3.8	2.6	6.4
2-23-33	.9121	397.5	56.9	1.048	2.1	3.95	4.5	1.5	6.0
3- 7-33	.9244	322.0	58.2	1.047	2.1	3.56	4.2	1.3	5.5
Stored at 54° F.									
12-17-32	.8576	508.6	58.4	1.044	2.0	3.34	3.1	1.6	4.7 (check)
1- 1-33	.8581	515.4	56.2	1.043	2.0	3.34	3.0	2.0	5.0
1-21-33	.8717	504.1	61.6	1.041	2.0	3.66	3.0	1.3	4.3
2- 6-33	.8901	474.2	56.5	1.045	2.0	3.25	3.7	1.7	5.4
2-27-33	.8841	419.6	54.3	1.047	2.0	3.37	3.9	1.6	5.5
3- 8-33	.8739	402.8	58.6	1.044	1.9	3.78	3.6	1.7	5.3
3-29-33	.8994	380.4	55.8	1.049	1.8	3.48	4.0	2.9	6.9
Stored at 48° F.									
12-17-32	.8576	508.6	58.4	1.044	2.0	3.34	3.1	1.6	4.7 (check)
12-30-32	.8693	536.8	57.9	1.046	1.9	3.21	3.6	2.0	5.6
1-19-33	.8823	576.4	56.8	1.045	1.8	3.50	3.3	2.2	5.5
2- 5-33	.8836	537.6	51.7	1.046	1.9	3.21	4.1	2.0	6.1
2-23-33	.9048	445.8	56.3	1.047	1.9	3.21	4.2	2.2	6.4
3-11-33	.9049	452.2	60.2	1.046	1.9	3.28	4.3	2.9	7.2
3-29-33	.8534	495.7	49.1	1.046	1.8	3.40	3.7	2.4	6.1
[illegible]	.8895	461.2	51.9	1.046	1.5	3.08	4.0	3.5	7.5

TABLE 15.—CHANGES IN COMPOSITION OF SILVER CLUSTER GRAPEFRUIT STORED AT VARIOUS TEMPERATURES—*Continued.*

Date of Analyses	Specific Gravity of Fruit	Weight of Fruit (gms.)	% Juice	Specific Gravity of Juice	% Acid (Citric)	pH	% Sugars (as Dextrose)		
							Free Reducing	Hydro-lyzable	Total
				Stored at 42° F.					
12-17-32	.8576	508.6	58.4	1.044	2.0	3.34	3.1	1.6	4.7 (check)
12-31-32	.8737	528.5	56.7	1.045	1.9	3.33	3.2	1.9	5.1
1-20-33	.8921	472.8	58.2	1.045	1.9	3.57	3.5	1.8	5.3
2- 5-33	.8656	456.4	51.4	1.045	2.0	3.20	3.5	1.9	5.4
2-26-33	.8771	496.1	49.7	1.044	1.9	3.77	3.8	1.4	5.2
3-12-33	.8625	448.3	55.7	1.044	1.9	3.35	3.5	3.0	6.5
3-29-33	.8807	438.4	50.8	1.048	1.9	3.36	4.2	2.7	6.9
4-21-33	.8844	398.5	55.9	1.048	2.0	3.78	3.9	2.7	6.6
				Stored at 37½° F.					
12-17-32	.8576	508.6	58.4	1.044	2.0	3.34	3.1	1.6	4.7 (check)
12-28-32	.8803	501.3	58.3	1.045	1.9	3.22	3.5	2.0	5.5
1-16-33	.8698	551.9	57.4	1.045	1.8	3.25	3.1	2.1	5.2
2- 3-33	.8935	447.2	58.3	1.046	2.3	3.45	3.9	1.3	5.2
2-22-33	.8841	483.5	52.0	1.044	1.8	3.26	3.7	2.2	5.9
3-15-33	.8902	403.2	54.1	1.047	2.0	3.27	4.1	2.9	7.0
3-31-33	.8469	512.2	50.8	1.046	1.7	3.19	3.2	2.7	5.9
4-23-33	.8643	466.8	54.2	1.047	1.7	3.78	3.6	3.3	6.9
				Stored at 32° F.					
12-17-32	.8576	508.6	58.4	1.044	2.0	3.34	3.1	1.6	4.7 (check)
12-29-32	.8575	500.6	57.6	1.044	1.9	3.28	3.1	2.1	5.2
1-16-33	.8680	515.8	57.9	1.045	1.8	3.24	3.2	2.0	5.2
2- 4-33	.8949	453.9	56.6	1.046	1.9	3.38	3.8	2.1	5.9
2-22-33	.9004	480.9	54.3	1.045	1.7	3.19	3.8	2.3	6.1
3-14-33	.8005	421.4	56.0	1.045	1.9	3.32	3.9	2.7	6.6
3-31-33	.8669	442.2	54.3	1.043	1.7	3.45	2.8	4.1	6.9
4-23-33	.8637	470.9	52.2	1.045	1.8	3.42	3.3	2.9	6.2

EXPERIMENTAL RESULTS WITH GRAPEFRUIT

The storage data of Silver Cluster and Marsh Seedless grapefruit are presented here, but the investigation includes similar results for the following varieties: Triumph, Duncan, Excelsior, Walters, McCarty and Florida Common.

SILVER CLUSTER GRAPEFRUIT

CHANGES IN COMPOSITION OF SILVER CLUSTER GRAPEFRUIT DURING STORAGE

Analyses of various physical and chemical characteristics of Silver Cluster grapefruit taken every two weeks from storage temperatures of 32°, 37½°, 42°, 48°, 54° and 58° F. and room temperature (70° to 80° F.) are summarized in Table 15.

All figures are averages of 36 fruits. The table gives the date of analysis, specific gravity of the fruit, weight of fruit, percent juice, specific gravity of juice, percent acid (titratable acidity), pH and percent sugars (free-reducing, hydrolyzable and total).

It will be noted that trends of the various characteristics were in the same direction for all temperatures but the rate of change was dependent upon temperature. The lower the temperature the less rapid the metabolic processes and changes in composition of the fruit.

Specific gravity of the whole fruit increased slightly during storage. Total weight of the fruit decreased, percent juice varied considerably but for the most part slightly decreased. Specific gravity of the juice increased slightly. Percent titratable acidity decreased, while pH values showed a tendency to increase, indicating that actual acidity also decreased with time in storage.

The free-reducing, hydrolyzable and total sugars increased with time in storage.

Loss in Weight.—Table 16 contains data on loss in weight after every two weeks of mature Silver Cluster grapefruit. All values are averages of 15 fruits which were stored on shelves of the various rooms and weighed individually. The loss in weight in grams and percent for each two-weeks period is given for the storage temperatures of 32°, 37½°, 42°, 48°, 54°, 58° F. and room temperature (70° to 80° F.).

Comparing the temperature effect, it may be seen that as a general rule the fruit lost most weight at the higher temperatures, the loss decreasing with descending temperatures, and

TABLE 16.—LOSS IN WEIGHT AFTER EVERY TWO WEEKS OF SILVER CLUSTER GRAPEFRUIT STORED AT VARIOUS TEMPERATURES.

After	32° F.		37½° F.		42° F.		48° F.		54° F.		58° F.		Room Temp.	
	Loss in Wt. (gms.)	Per-cent Loss	Loss in Wt. (gms.)	Per-cent Loss	Loss in Wt. (gms.)	Per-cent Loss	Loss in Wt. (gms.)	Per-cent Loss	Loss in Wt. (gms.)	Per-cent Loss	Loss in Wt. (gms.)	Per-cent Loss	Loss in Wt. (gms.)	Per-cent Loss
2 Wks.	8.9	2.1	9.9	2.6	11.6	2.6	14.8	3.2	22.3	4.7	25.4	5.6	22.3	4.7
4 "	16.1	3.8	17.2	4.6	19.7	4.5	25.0	5.5	37.6	8.0	36.9	8.4	36.2	7.8
6 "	22.0	5.3	23.4	6.4	27.6	6.4	33.7	7.4	50.2	10.9	49.6	11.5	47.6	9.5
8 "	27.9	6.8	29.4	8.1	35.6	8.3	42.9	9.6	62.2	13.6	63.7	14.9	58.9	13.0
10 "	34.7	8.5	34.8	9.7	43.0	10.1	53.2	12.0	75.5	16.6	82.4	18.8	—	—
12 "	41.5	10.3	40.7	11.5	50.4	12.0	63.3	14.5	90.1	19.9	100.1	23.7	—	—
14 "	46.5	11.6	46.3	13.2	57.0	13.8	72.0	16.8	103.0	23.1	119.6	29.4	—	—
16 "	52.0	13.0	51.2	14.7	65.4	16.1	82.6	19.8	121.1	27.7	—	—	—	—
18 "	57.2	14.4	56.5	16.3	72.6	17.9	—	—	136.8	32.0	—	—	—	—
Avg. Weekly Loss	6.4	1.6	6.3	1.8	8.1	2.0	10.3	2.5	15.2	3.6	17.0	4.4	14.5	3.3

being least at 32° F. In other words, loss in weight in storage is directly related to the temperature—the higher the temperature of the storage room the greater the loss in weight of the fruit. It is of interest to note here that loss in weight in both grams and percent is higher in the refrigeration rooms held at 54° and 58° F. than it is in the fruit held at room temperature (70° to 80° F.). This difference can probably be explained from the fact that fruits held in the rooms with temperatures of 54° and 58° F. were exposed to a constant draught of air circulating through the rooms, while this was not true of the fruit held at room temperature.

Fruit held at any storage temperatures lost the most weight during the first week of storage, decreasing gradually with time in storage. This is more noticeable in fruit held at the lower temperatures than that held at the higher temperatures.

The average weekly losses in grams and percent were obtained over an 18 weeks' storage period and are given in Table 16 for the sake of comparison (Fig. 13).

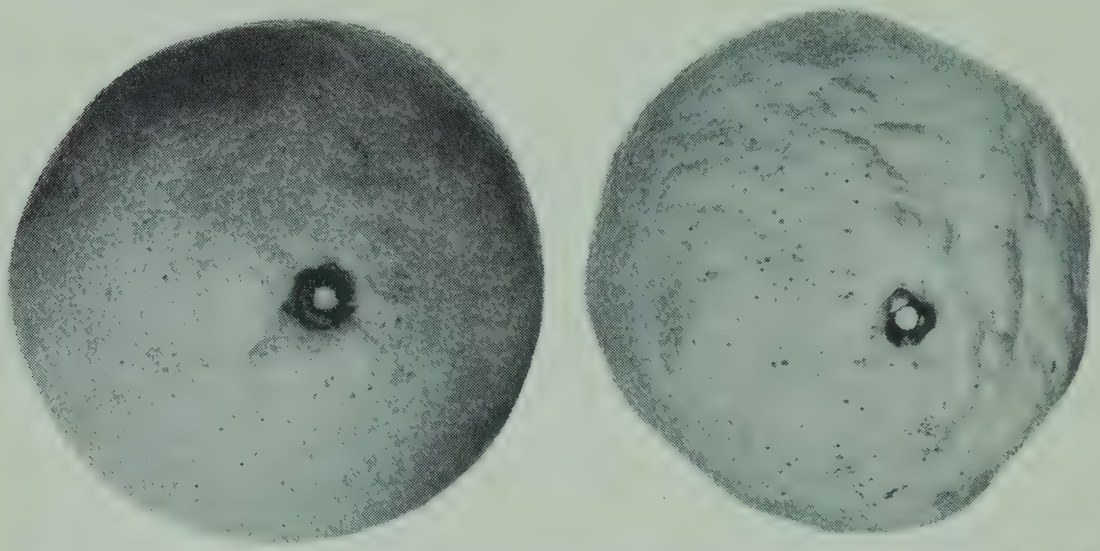

Fig. 13.– Typical Silver Cluster grapefruit after three months' storage at (left) 37½° F. and (right) room temperature (70° to 80° F.).

Keeping Quality During Storage.—In Tables 17 and 18 are given the data compiled from periodical examinations of the fruits stored at various temperatures, from which it is possible to compare the effect of storage temperatures upon keeping quality.

Table 17 gives the percent of mild and severe pitting at various times throughout the storage period, while Table 18 gives the effect of temperature on decay at various storage intervals. No records were kept of the various types of decay, but it is

TABLE 17.—EFFECT OF TEMPERATURE ON PITTING OF SILVER CLUSTER GRAPEFRUIT DURING STORAGE.

Storage Temperature (° F.)	Percent Pitting							
	After 4 Weeks		After 8 Weeks		After 12 Weeks		After 16 Weeks	
	Mild	Severe	Mild	Severe	Mild	Severe	Mild	Severe
58	5	0	10	5	10	5	10	5
54	25	5	30	10	30	15	20	25
48	20	5	20	15	20	20	20	25
42	10	5	15	20	25	25	30	25
37½	20	10	25	15	25	30	25	45
32	32	10	25	40	45	40	35	60

TABLE 18.—EFFECT OF TEMPERATURE ON DECAY OF SILVER CLUSTER GRAPEFRUIT DURING STORAGE.

Storage Temperature (° F.)	Percent Decay After							
	2 Weeks	4 Weeks	6 Weeks	8 Weeks	10 Weeks	12 Weeks	16 Weeks	20 Weeks
58	1.0	9.0	38.0	51.0	51.0	51.0	—	—
54	0.0	2.0	11.0	27.0	27.0	38.0	39.0	46.0
48	0.0	0.5	1.0	14.5	29.5	53.0	59.0	67.5
42	0.0	0.5	0.5	0.5	1.5	12.0	12.0	22.0
37½	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5

safe to say that 90 percent was caused by stem-end rot organisms. Percentage of pitting was figured on the total number of fruits placed in storage rather than the number in storage at any one time during the storage period. Decayed fruits were removed, some having been mildly or severely pitted and some not having been pitted at all before decay set in, thus making it difficult to keep pitting records—a fact which must be taken into consideration in interpreting the data.

Storage Pitting.—The pitting was more severe and appeared sooner in the fruit stored at 32° F. and least in the fruit stored at 58° F. The values given in Table 17 indicate that the amount, severity and rapidity of storage pitting can be correlated with temperature; with an increase in storage temperature there is a decrease in pitting. After only eight weeks in storage, pitting of fruit at the colder temperatures (32° and 37½° F.) was of such a degree as to cause 35 to 40 percent of the fruit to be unmarketable. After 16 weeks from one-half to three-fourths of the fruit held at the lower temperatures (32° to 37½° F.) were unmarketable due to pitting. From the standpoint of taste and texture of pulp, the fruit was marketable at this time, but the pitting of the rind was such as to make the fruit unmarketable from the standpoint of appearance. Fruit held at the higher temperatures with less pitting was also marketable as to taste and texture, although it was not as good as that held at lower temperatures, due to excessive shriveling. That which did not decay was considered only fair in this respect.

Decay.—The figures of Table 18 for the percent decay indicate a decided effect of temperature on the amount of decay. The figures show very little decay of grapefruit held at the lower temperatures (32° and 37½° F.) but show much decay at the higher temperatures (54° and 58° F.). There is a direct relation between decay and temperature. The rate in percent decay followed closely Van't Hoff's rule of the relation of temperature to chemical reactions—that is, the rate approximately doubles for a 10° increase in temperature.

DISCUSSION

The fruit stored at the lower temperatures, where the decay was negligible, had an appreciable amount rendered unmarketable by pitting. The fruit stored at the higher temperatures, where the pitting was negligible, had a high percentage of decay. The fruit held at the intermediate temperatures (42° and 48° F.) did not have the high percentage decay of the higher temperatures nor the severe pitting of the lower temperatures, but had a certain amount of both. Considering all of the storage temperatures, it appears that the best temperatures for storage of unwrapped, untreated Silver Cluster grapefruit are the temperatures from 37½° to 42° F., as the percent marketable fruit at any one time of the storage period was slightly higher at these temperatures than at those higher or lower. Also, the fruit held at temperatures lower than 37½° F. did not stand up as well when removed from storage as did those held at higher temperatures.

MARSH SEEDLESS GRAPEFRUIT

Forty-six commercially packed boxes of Marsh Seedless grapefruit were shipped by truck to Gainesville from Lake Wales, where they were packed. They were in cold storage in six to 10 hours after being picked. In addition, 10 boxes of fruit were placed out on shelves in the refrigeration rooms and weighed individually every week to determine the loss in weight during storage. The fruits were so placed that the only object touching them was the shelf on which they rested.

CHANGES IN COMPOSITION OF MARSH SEEDLESS GRAPEFRUIT DURING STORAGE

Table 19 contains data on changes in composition as obtained from analyses of the Marsh Seedless grapefruit beginning April 6, when they were placed in storage, and continuing at regular intervals throughout the storage period. All figures in the table are averages of 36 fruits except the check, which is an average of 30 fruits.

In Table 19 the effect of temperature on stored fruit is readily observed. Cold temperatures retard the life processes of the fruit, there being a direct relationship between the rate of change during storage and the temperature, the lower the temperature the less change in the constituents of the fruit. Since the degree of change in constituents of the fruit during storage is dependent upon storage temperatures, the following statements can be made for changes in composition of the fruit at any of the storage temperatures.

There was a decrease in total weight of fruit with increased time in storage. There was a slight decrease in specific gravity of the whole fruit and a slight increase in specific gravity of the juice during storage. The figures for percent juice showed a slight decrease with the increase in the storage period.

TABLE 19.—CHANGES IN COMPOSITION OF MARSH SEEDLESS GRAPEFRUIT STORED AT VARIOUS TEMPERATURES FOR FOUR MONTHS.

Date of Anaylses	Specific Gravity of Fruit	Weight of Fruit (gms.)	% Juice	Specific Gravity of Juice	% Acid (Citric)	pH	% Sugars (as Dextrose)		
							Free Reducing	Hydro-lyzable	Total
				Stored at Room Temperature (70-80° F.)					
4- 6-33	.8672	554.4	56.6	1.040	2.0	3.0	3.29	1.90	5.19 (check)
6- 1-33	.8659	481.4	55.9	1.041	1.9	3.2	3.57	1.98	5.55
7- 9-33		All Fruit Decayed							
				Stored at 58° F.					
4- 6-33	.8672	554.4	56.6	1.040	2.0	3.0	3.29	1.90	5.19 (check)
6- 2-33	.8627	500.8	53.4	1.042	1.9	3.8	3.57	2.37	5.94
7- 9-33	.8654	475.5	54.5	1.043	1.9	3.5	3.46	2.72	6.18
8- 4-33		All Fruit Decayed							
				Stored at 54° F.					
4- 6-33	.8672	554.4	56.6	1.040	2.0	3.0	3.29	1.90	5.19 (check)
6- 2-33	.8849	412.1	55.7	1.045	2.2	3.9	3.58	2.30	5.88
7- 8-33	.8620	422.2	56.2	1.049	2.1	3.9	3.50	2.00	5.50
8- 4-33	.8626	350.3	52.3	1.051	2.0	3.5	3.63	3.12	6.75
				Stored at 48° F.					
4- 6-33	.8672	554.4	56.6	1.040	2.0	3.0	3.29	1.90	5.19 (check)
6- 1-33	.8669	430.8	54.9	1.042	1.9	3.8	3.40	1.90	5.30
7- 9-33	.8628	419.5	54.4	1.045	2.1	3.4	3.35	2.32	5.67
8- 5-33	.8560	436.2	55.1	1.044	1.9	3.2	3.35	3.20	6.55

TABLE 19.—CHANGES IN COMPOSITION OF MARSH SEEDLESS GRAPEFRUIT STORED AT VARIOUS TEMPERATURES FOR FOUR MONTHS—*Continued.*

Date of Analyses	Specific Gravity of Fruit	Weight of Fruit (gms.)	% Juice	Specific Gravity of Juice	% Acid (Citric)	pH	% Sugars (as Dextrose) Free Reducing	Hydro-lyzable	Total
				Stored at 42° F.					
4- 6-33	.8672	554.4	56.6	1.040	2.0	3.0	3.29	1.90	5.19 (check)
6- 2-33	.8460	432.1	53.8	1.043	2.1	4.0	3.32	2.55	5.87
7- 8-33	.8609	465.0	55.8	1.040	1.7	3.4	3.30	2.88	6.18
8- 5-33	.8570	425.1	54.3	1.044	1.9	3.1	3.40	2.55	5.95
				Stored at 37½° F.					
4- 6-33	.8672	554.4	56.6	1.040	2.0	3.0	3.29	1.90	5.19 (check)
5-30-33	.8420	428.2	56.1	1.043	1.9	3.3	3.20	2.25	5.45
7- 8-33	.8540	398.8	53.5	1.045	2.1	3.3	3.98	2.80	6.78
8- 4-33	.8366	436.0	51.5	1.047	2.0	2.9	3.42	2.90	6.32
				Stored at 32° F.					
4- 6-33	.8672	554.4	56.6	1.040	2.0	3.0	3.29	1.90	5.19 (check)
5-30-33	.8652	438.7	57.1	1.045	1.9	3.5	3.58	3.14	6.72
7- 8-33	.8538	475.8	50.6	1.040	1.9	3.8	3.89	3.00	5.89
8- 4-33	.8590	413.3	52.8	1.043	1.8	3.4	2.90	2.95	5.85

Values for percent sugar indicated an increase in free-reducing, hydrolyzable and total sugars with increased time in storage.

There was very little change in acidity of the fruit but the figures indicate a very slight decrease in both titratable and effective acidity. Should the figures have been calculated on percent acid per gram of dry weight instead of green weight, the percent decrease would have been much more pronounced.

Less change took place in the composition of fruit stored at lower temperatures than that stored at higher temperatures. Reduction in weight of fruit was due mostly to loss in moisture, and this tends to make increased values in those fruits which were held at the higher temperatures where the moisture loss is highest. In the case of these characteristics, such as sugar, where there is an increase naturally with time in storage, this increase was accentuated by this loss in moisture which makes the juice samples more concentrated. On the other hand, in those characteristics such as acidity, where there was a decrease with time in storage, this decrease was lessened by this loss in moisture which makes the juice samples more concentrated.

The rate of change was dependent upon the temperature; the higher the temperature the faster the rate of change in the composition of the fresh fruit.

Loss in Weight.—Table 20 is a tabulation of the loss in weight in grams and percent of mature Marsh Seedless grapefruit stored at 32°, 37½° and 48° F. for 22 weeks. The fruits were weighed individually every two weeks and these weights were averaged to give the values of the table.

TABLE 20.—LOSS IN WEIGHT AT VARIOUS INTERVALS OF MARSH SEEDLESS GRAPEFRUIT STORED AT DIFFERENT TEMPERATURES.

After	32° F.		37½° F.		48° F.	
	Loss in Weight (gms.)	Percent Loss	Loss in Weight (gms.)	Percent Loss	Loss in Weight (gms.)	Percent Loss
2 Wks.	8.4	1.9	8.3	1.9	10.1	2.7
4 Wks.	15.9	3.6	16.7	3.9	20.5	5.3
6 Wks.	22.1	5.1	23.4	5.5	31.1	8.0
8 Wks.	29.4	6.8	32.1	7.7	42.6	10.8
10 Wks.	36.4	8.5	40.4	9.8	54.4	13.4
12 Wks.	42.9	10.1	49.1	12.1	65.2	15.5
14 Wks.	49.4	11.7	57.9	14.4	75.2	17.8
16 Wks.	55.5	13.3	66.7	16.8	83.7	19.8
18 Wks.	62.1	15.0	76.7	19.5	93.4	22.1
20 Wks.	68.8	16.7	85.5	21.8	103.0	24.2
22 Wks.	76.8	18.7	94.2	24.1	111.0	25.8

Comparing the temperature effect, it may be seen that, as a general rule, fruit lost most weight at 48° F. and least at 32° F. The figures show that with an increase in the storage temperature there was an increase in the loss of weight of the fruit.

KEEPING QUALITY OF COMMERCIALLY PACKED FRUIT

The tabulation of the percent marketable and unmarketable fruit at the four storage temperatures at various times throughout the storage period is given in Table 21. The percent unmarketable fruit caused by pitting and decay, as well as the percent marketable fruit, is given for each of the four storage temperatures.

Storage Pitting.—The figures show that heaviest pitting occurred at the lower temperatures of 32° and 37½° F. and lightest at 42° and 48° F. Amount of pitting and percent fruit made unmarketable by pitting were dependent upon the temperature and length of storage; the colder the temperature, the more severe the pitting and the higher the percentage fruit made unmarketable by pitting, while the longer the fruit was held in storage, the more severe and abundant the pitting became.

Decay.—The least amount of decay occurred at the low temperatures of 32° and 37½° F., with increasing amounts at higher storage temperatures, the highest percentage decay occurring at the highest storage temperature.

DISCUSSION

Considering the results from a marketing standpoint, the figures show that the storage temperatures of 32° to 37½° F. are the best temperatures for storing untreated, unwrapped Marsh Seedless grapefruit. At these temperatures close to 100 percent of the fruit was still in excellent condition after the first month of storage, around 90 to 95 percent after two months' storage, and 93 percent after the third month. Pitting was heavy at these temperatures but decay was almost negligible. Fruit held at 37½° F. kept almost as well as that held at any other temperature and had less loss in weight and better texture and taste.

There was a curing effect on the fruit held at 48° F. The rind became hard and dry after a few weeks' storage, serving to prevent the entrance of organisms or fungus spores, thus reducing the amount of decay to that obtained at 37½° and 42° F.

From the results of this work, it was found that Marsh Seedless grapefruit cannot be stored satisfactorily for periods longer

TABLE 21.—EFFECT OF TEMPERATURE AND LENGTH OF STORAGE PERIOD ON THE KEEPING QUALITY OF MARSH SEEDLESS GRAPEFRUIT.

Time in Storage (wks.)	Stored at 32° F.			Stored at 37½° F.			Stored at 42° F.			Stored at 48° F.		
	% Not Marketable Because of		Percent Marketable	% Not Marketable Because of		Percent Marketable	% Not Marketable Because of		Percent Marketable	% Not Marketable Because of		Percent Marketable
	Pitting	Decay		Pitting	Decay		Pitting	Decay		Pitting	Decay	
0	0	0.0	100.0	0	0.0	100.0	0	0	100.0	0	0	100.0
5	0	0	100.0	10	0.0	90.0	5	0	95.0	0	3.1	96.9
10	5	1.6	93.4	15	1.6	83.4	5	12.5	82.5	3	17.8	79.2
15	7	14.1	78.9	20	31.3	48.7	10	45.3	44.7	3	19.4	77.6
20	15	28.1	56.9	20	76.5	3.4	10	87.5	2.5	10	23.4	66.6
25	15	35.9	49.1	—	93.8	0.0	—	98.8	1.2	10	39.1	50.9

than two or three months unless treated or wrapped (*15*). It has been previously reported by Hawkins and Barger (*7*) that Marsh Seedless grapefruit would not lend itself to cold storage. The results obtained here indicate that this variety is equal to other grapefruit varieties, providing first class fruit is used and the fruit has not been allowed to become too mature.

No complete records were taken of the fruit after its removal from cold storage to temperatures of the retail stores. Observations and taste samples made of the fruit indicated that the fruit from the warmer temperatures (42° and 48° F.) remained in a marketable condition for three weeks after removal, while those from lower temperatures such as 32° and 37½° F. remained in a marketable condition for from one to two weeks but were of a much superior quality both as to taste and appearance.

SUMMARY

The effect of various temperatures and stages of maturity on the changes taking place in the physical and chemical characteristics and the keeping quality of several varieties of Florida oranges and grapefruit was studied.

It was found that cold temperatures retarded the life processes of citrus fruit, there being a direct relation between rate of change during storage and temperature, the lower the temperature the less change in composition of the fruit.

ORANGES

Besides the decrease shown in total weight, volume and percent juice of Pineapple oranges, very slight changes occurred in any of the other constituents analyzed. The changes in all other analyzed constituents were all within the limit of error of analyses or variation in content among individual fruits. Changes in taste and flavor were much more pronounced than those in composition. The methods of analysis used were not determinative enough to show the difference in composition of fruit held at the different temperatures which were clearly brought out by taste, quality and appearance. The figures are of value, however, in that they show that the change in composition during cold storage is slow and the various constituents change only slightly over a long period of time.

With the Valencia oranges there was a decrease in total weight, specific gravity, percent juice, and percent acid. There was an increase in total sugars with time in storage and an increase in pH values, indicating a decrease in effective acidity. There was an increase in the specific gravity of the juice.

Valencia oranges analyzed when removed from the tree and at intervals after storing when under-mature (March 1), mature (April 1), and over-mature (May 1 and June 1) showed that, with but few exceptions, trends of change in the various characteristics were in the same direction during storage of the fruit as when still on the tree, but to a much slower degree. The metabolic or life processes of the fruit were greatly retarded, more than half at 32° and 37½° F. storage or, in other words, the metabolic processes occurred at one-half the rate of normal metabolism on the tree. Higher storage temperatures had relatively less retarding effects on the metabolism of the fruit.

There was less loss in weight in all varieties at the lower temperatures than at the higher—with an increase in storage temperature there was an increase in loss in weight of fruit. The weekly loss in weight of fruit held at the lower temperatures increased as the storage period increased, while the loss in weight of that held at the higher temperatures decreased as the storage period increased, indicating a curing effect on the fruit by the higher storage temperatures.

It was found that loss in weight of fruit increases as maturity increases (maturity at time of picking and storing). Fruit of under-normal maturity lost the least weight at all storage temperatures; fruit of normal maturity next, and fruit past normal maturity most at any of the storage temperatures.

Storage pitting occurred to a negligible amount at all temperatures with a slight degree more at the colder than the warmer temperatures. More pitting occurred in the Pineapples than Valencias.

Amount of decay varied directly with the storage temperature and length of storage—the higher the temperature the higher the percent decay and the longer the storage period the higher the percent decay. Decays occurred fairly early at the warmer temperatures but not until 8 to 12 weeks of storage at the colder temperatures and then only slightly. Most of the decay encountered throughout the storage period was stem-end rot in both Pineapple and Valencia experiments.

Percent of marketable fruit varied indirectly with temperature and length of time in storage—the lower the temperature the higher the percent marketable fruit and the longer the storage period the lower the percent marketable fruit.

The time fruit remained in marketable condition after removal from cold storage to room temperature varied as to temperature at which the fruit had been held and to length of time the fruit had been held at this temperature. Fruit held at 37½° F. remained marketable longest and in best condition when removed to room temperature. That at 32° F. decayed rapidly and had a terpenous taste, while the taste and quality of that at temperatures higher than 37½° F. was not as good when removed from storage. Fruit held in storage at 37½° F. for five weeks remained marketable two to three weeks after removal, while that held 15 and 20 weeks remained marketable a few days to one week out of storage.

Both Pineapple and Valencia oranges kept best at 32° F. and 37½° F. of any of the temperatures tried, but the fact that the fruit held at 37½° F. remained marketable a longer time and in better condition when removed from storage would place this temperature as best for unwrapped, untreated oranges. Temperatures below 37½° F., however, were found to be preferable for oranges to temperatures above.

GRAPEFRUIT

In all varieties analyzed there was a decrease in total weight of fruit with increased time in storage. There was a slight decrease in specific gravity of the fruit and a slight increase in specific gravity of the juice during storage. The figures for percent juice showed a decrease with increased time in storage.

The values for percent sugars showed an increase in free-reducing, hydrolyzable and total sugars with increased time in storage.

There was very little change in acidity of the fruit. The figures for both titratable and effective acidity showed a slight decrease with time in storage.

Trends of change in various characteristics were in the same direction for all temperatures but the rate of change was dependent upon the temperature. The lower the temperature, the less rapid the changes in composition of the fruit.

Comparing temperature effect on loss in weight during storage, as a general rule for all varieties tested fruit lost most weight at the higher temperatures, decreasing in amount of weight lost with decreasing temperatures. The fruit lost most weight during the first week of storage, decreasing gradually with time in storage, it being more pronounced at the colder temperatures.

The amount, severity and rapidity of storage pitting varied inversely with the temperature; with an increase in storage temperature there was a decrease in pitting. Severe pitting occurred on fruit held at 32° and 37½° F. several weeks after storage while in that held at 54° and 58° F. pitting was never severe until after three and four months' storage. This is true of both Silver Cluster and Marsh Seedless grapefruit.

The amount, severity and rapidity of decay varied directly with the temperature; with an increase in storage temperature there was an increase in amount of decay. Decay was almost negligible at 32° and 37½° F. and very severe at the warmer storage temperatures in both varieties.

The amount of storage pitting was about the same in both varieties, but there was slightly more decay in the Marsh Seedless variety than in the Silver Cluster. The general appearance was slightly better in the Silver Cluster variety. Both varieties kept well for two to three months at the colder temperatures, but deteriorated rapidly thereafter.

When removed from storage to room temperature fruit from 37½° and 42° F. remained marketable longest and in best condition.

The fruit from 32° F. deteriorated more rapidly when removed from cold storage than that held at 37½° F., while the fruit held at temperatures higher than this took on a stale, flat taste more rapidly when removed from storage.

Considering all points, loss in weight, decay, pitting, keeping quality before and after removal, taste, marketability at any one time, the best temperatures for storage of unwrapped, untreated Silver Cluster and Marsh Seedless grapefruit were from 37½° to 42° F., preferably 37½°. The percent marketable fruit at any one time of the storage period was slightly higher at these temperatures than at those higher or lower.

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COLD STORAGE STUDIES OF FLORIDA CITRUS FRUITS

II. Effect of Various Wrappers and Temperatures on the Preservation of Citrus Fruits in Storage

ARTHUR L. STAHL AND WILLARD M. FIFIELD

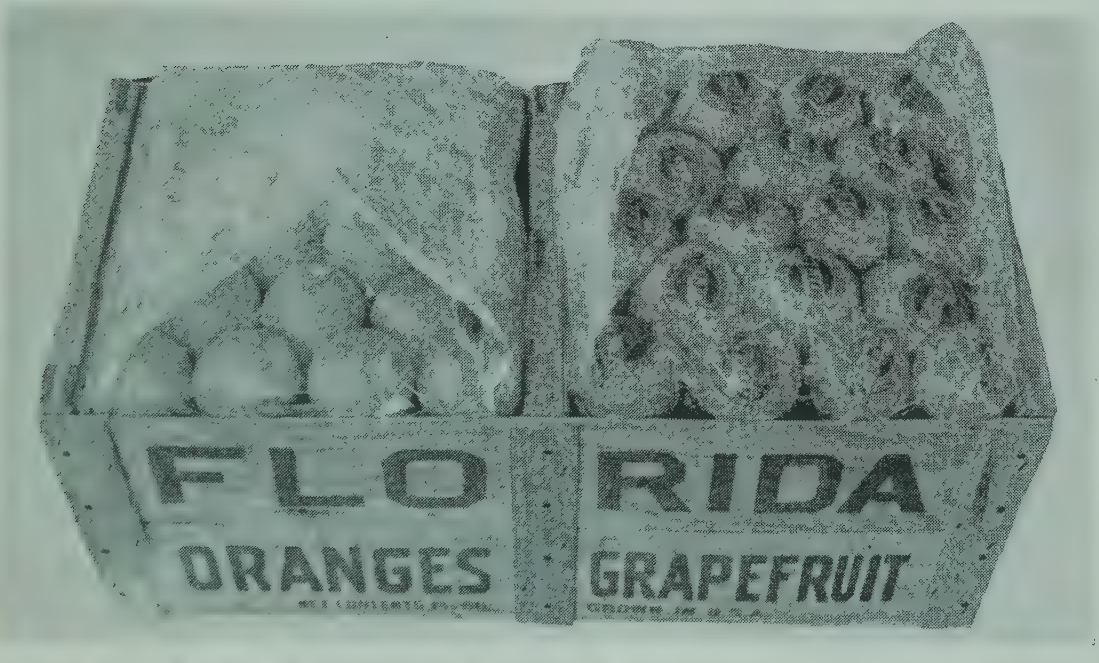

Fig. 1.—Box liners of moistureproof materials, as well as individual wrappers of the same materials, aided in keeping citrus fruits in good condition during cold storage. The above picture shows Valencia oranges packed in a commercial crate. Moistureproof cellophane liners were used, the one in the left half being sealed and folded over, while the one on the right is in the form of a bag with flap sealed around the edge. Fruit on the right side is individually tissue-wrapped.

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COLD STORAGE STUDIES OF FLORIDA CITRUS FRUITS

II. Effect of Various Wrappers and Temperatures on the Preservation of Citrus Fruits in Storage

By Arthur L. Stahl and Willard M. Fifield

INTRODUCTION

Recent research in the utilization of citrus by-products, as well as a growing tendency toward standardization and more uniform distribution to markets throughout the year, have caused considerable emphasis to be placed on the cold storage phase of citrus marketing. Any investigation of the superiority of certain wrappers and temperatures in preserving the quality of the fruit during storage should prove of considerable interest and importance to the citrus industry.

With this in mind, studies were instituted concerning the effect of various wrappers and temperatures on the general appearance, taste, loss in weight, on the length of time fruit can be held in storage in marketable condition, on the occurrence of pitting and decay, and on the length of time fruit can be held after removal from storage.

PREVIOUS INVESTIGATIONS

DeVilliers (*5*)[1] examined a number of ordinary fruit wrappers which were composed chiefly of wood fibers and manufactured principally from pine, spruce, poplar or other soft woods. The tensile strength of the wrappers was taken as one of the principal means of gauging their quality. He found that a rapid absorption of moisture by the cellulose fibers took place when the air had a relatively high humidity, such as is generally the case in cold storage. With this absorption there was a marked lowering in the tensile strength of the paper. By means of a simply constructed apparatus he measured the relative permeability of the various wrappers to air, and laid particular emphasis on the fact that if either moisture, carbon dioxide, or esters exhaled by the fruit were allowed to accumulate around it, deterioration of some kind or other was sure to follow. The investigations included some papers which permitted absolutely no passage of air even under pressure. He describes greased papers, sometimes recommended for wrapping certain kinds of fruit which tend to develop "scald" and other skin diseases in storage, as containing specific absorbents for the particular esters exhaled by the fruit which caused the physiological breakdown of the epidermal cells.

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[1] Italic figures in parentheses refer to "Literature Cited" in the back of this bulletin.

Birdseye (*1*), in describing wrapping materials used in the packaging of quick-frozen fresh products, states that one of the most valuable characteristics of pure vegetable parchment is that it will not disintegrate in the presence of water. Ordinary cellophane proved unsatisfactory because it was not moisture-vapor-proof and the sheets adhered tightly to one another. He found moistureproof cellophane one of the best materials available, as it is almost completely transparent and has a high resistance to the passage of moisture vapor and other gases. The individual sheets did not stick together and the material itself was waterproof and greaseproof. Moistureproof cellophane was found to be more resistant to the passage of moisture vapor than waxed papers, parchment or ordinary cellophane.

Brown (*3*) observed that waxed papers reduced moisture loss from certain vegetables but that decay was greater than with vegetables not wrapped. He also found that paper wrappers had some cushioning value which helped protect perishable products from mechanical injury. Both sunlight and ultra-violet light passed freely through cellophane and waxed papers. Parchment paper also transmitted considerable sunlight and ultra-violet light but whalehide excluded almost entirely both of these forms of light. The chemical effects resulting from the use of wrappers were negligible.

Brooks and others (*2*) found that unoiled wrappers had no effect in controlling apple scald, and that while paraffined wraps caused considerable reduction in amount of scald, they proved far inferior to oiled wraps. Many types of oiled wrappers were tested and most of them were found efficient in scald control.

The value of wrapping apples in oiled paper was shown by Kidd (*12*) in the case of Newton Wonder, a scald susceptible variety. After four and one-half months in ordinary storage, fruits in oiled paper remained about 48 percent sound as compared with 5 percent for waxed paper and 3 percent for unwrapped fruit.

Henrickson (*11*) found that when the fruit was removed from the cold room condensation was always very great. The tissue wraps became entirely soaked within a few hours, causing a soggy condition of the pack. Wrapped fruit developed "scald spot" (pitting) as well as the fruit without wraps.

Tindale (*16*) showed that Washington Navel oranges when wrapped remained in a firmer condition and prevented the formation of mold "nests". The best storage temperature appeared to be 36° F.

Young and Read (*17*), working in Australia with Washington Navel and Valencia oranges, found that carefully handled fruit which had not been through a commercial packing plant kept much better in cold storage than commercially packed fruit. They also found that sweating, which took place during transportation, added to the keeping qualities of the unwrapped fruit. Fruit transported loose in boxes held up much better than packed fruit.

Cooley and Crenshaw (*4*) successfully controlled the spread of Botrytis rot among pears by the use of wrappers impregnated with a 25 percent solution of copper sulfate, the dry paper carrying about 1.4 percent of its weight as metallic copper in the form of copper sulfate. Evidence of injury was noticed where wet pears were wrapped in the chemically-treated paper.

Powell and Fulton (*14*) experimented with tissue, parchment, waxed and unprinted newspaper wrappers on apples in cold storage, and found that the fruit wrapper retarded the ripening of the fruit, preserved its brighter color, checked transpiration, protected from bruising, and prevented the spread of fungus spores from decayed to perfect fruit. No important difference was noticeable in the efficiency of the different wrappers except that a mold developed freely on the parchment paper at 32° and 36° F. A variety was found to differ in keeping quality when grown in different parts of the country or in the same locality under different conditions. The character of the season also modified the keeping quality of the fruit.

Experiments conducted by Hawkins and Magness (*10*) in 1920 showed that pitting, one of the most serious problems to be met in the cold storage of citrus, was made less serious at relatively high cold storage temperatures (about 45° F.). More recent work by Hawkins (*8*) and Hawkins and Barger (*9*) indicates that under certain conditions relatively low cold storage temperatures (31°-32° F.) give the best results. They point out that "curing" the fruit at about 70° F. for 10 days materially reduces the amount of "pitting" in the stored fruit. They also find that the Marsh Seedless grapefruit is not well adapted for cold storage.

Overholser (*13*), working on marine refrigeration of California oranges, found the temperature of 36°-38° F. most satisfactory. Higher temperatures resulted in wilting of the fruit and excessive losses from decay, and lower temperatures resulted in the deterioration (pitting) of the rind.

Friend and Bach (*7*), working with Texas citrus fruit, found a temperature of 45° F. best suited for cold storage of grapefruit and 31°-32° F. most satisfactory for holding Valencia oranges in storage. They were able to keep grapefruit eight weeks and oranges as long as 20 weeks.

CONDITIONS OF EXPERIMENT

The fruit was obtained from the groves of the Experiment Station, Gainesville; Citrus Experiment Station, Lake Alfred; Mammoth Grove, Inc., Lake Wales; Wetumpka Fruit Company, Lowell; and Clermont Citrus Growers' Association, Clermont. Some time was consumed in transporting the fruit from the grove to the cold storage plant, but an effort was made to place the fruit in cold storage as soon after picking as practicable. At no time was the interval between picking and storing more than 48 hours, and for the most part it was less than 24 hours.

The fruit was stored in the refrigeration plant at the Agricultural Experiment Station in Gainesville, which has been described fully in Bulletin 303 (*15*).

EXPLANATION OF TERMS

The purpose of placing citrus fruits in cold storage is to prevent the development of decay, retard respiration and delay deterioration, in order to lengthen the life of the fruit. Fungus diseases that affect the fruit can best be controlled by storage at the lowest possible temperatures without freezing. There are certain physiological disturbances, however, that arise at these low temperatures, chief among which are pitting and scald. These so-called physiological diseases appear to be closely connected with the respirational interferences and possibly enzyme activity of the fruit at low temperatures.

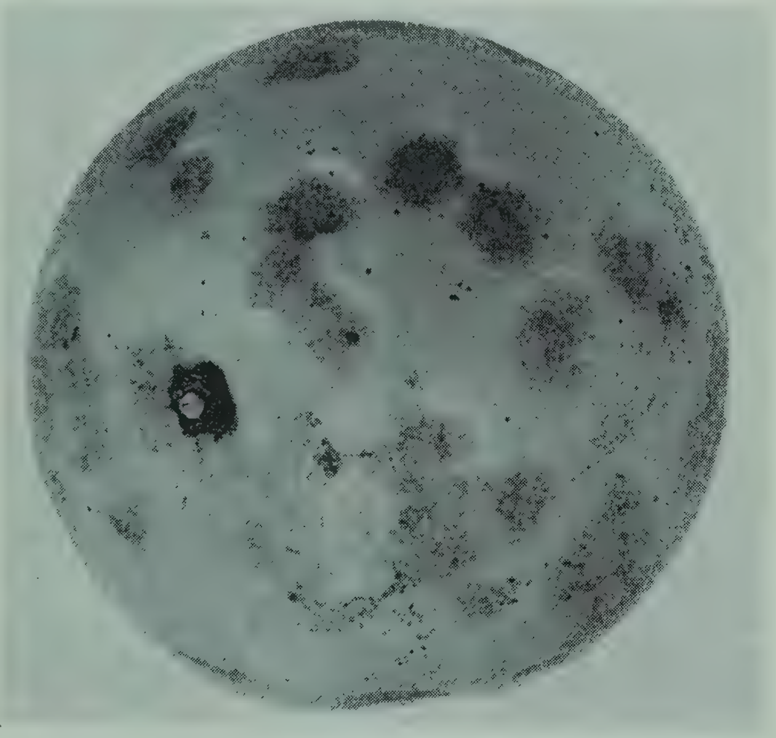

Fig. 2.—Typical "storage pitting" on grapefruit.

Pitting is one of the most serious problems encountered in holding citrus fruit in cold storage and is one of the most difficult to control. The sunken spots are confined to the flavedo (the outside layer of rind containing the oil vesicles) and are formed by a breakdown of this tissue. Pitting first appears as small slightly sunken spots, which increase in size and may coalesce, forming irregular-shaped patches. With age, or upon exposure to warmer temperatures, the spots gradually

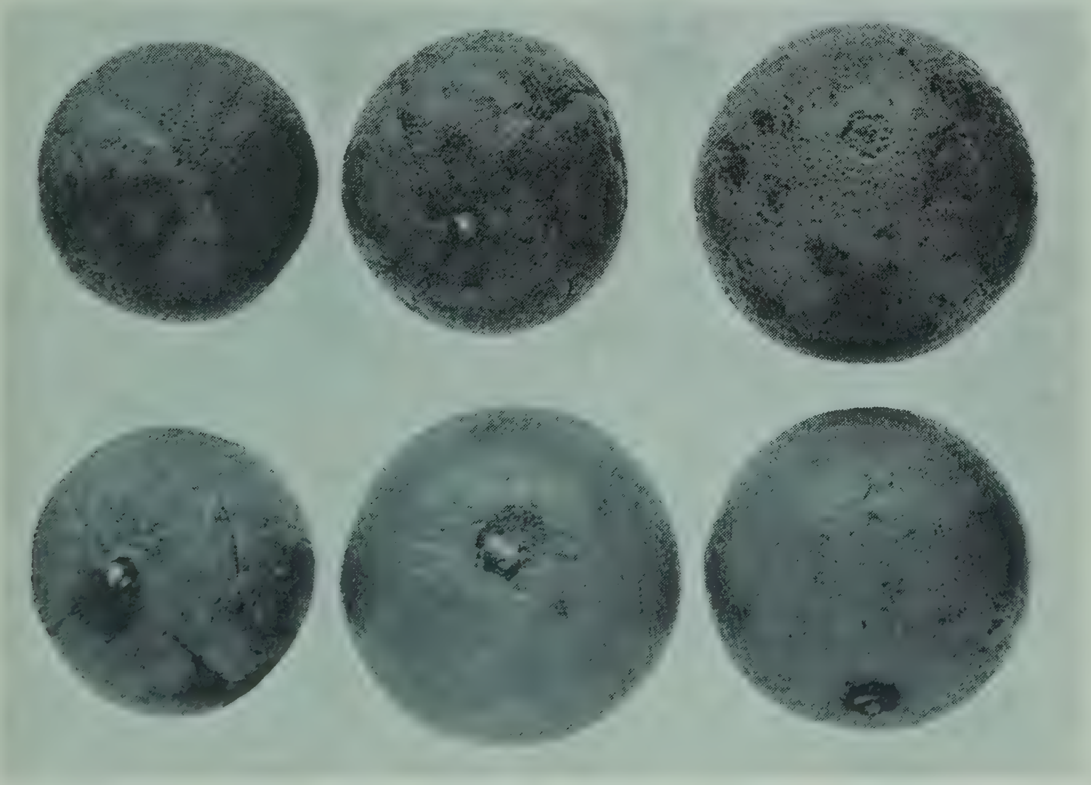

Fig. 3.—Typical forms of "storage pitting" on oranges. The type at top left often is called "scald". Pitting around button often is called "stem-end drying".

turn brown. Besides detracting from appearance, keeping quality and marketability of citrus fruits, the pitted spots serve as an entrance for decay-producing fungi. Pitting has no effect on the quality or taste of the fruit directly. (Figs. 2 and 3.)

Scald is also due to a physiological disorder or breakdown of the rind tissue of cold stored fruit. The injury to the rind is somewhat similar to mild pitting, but it is more superficial. Scald may often appear on fruits which are also pitted and in many respects the two troubles appear to be related. Scald also renders the fruit unmarketable from the standpoint of appearance and the physiological breakdown of the rind lowers the resistance of the fruit to decay (Fig. 3).

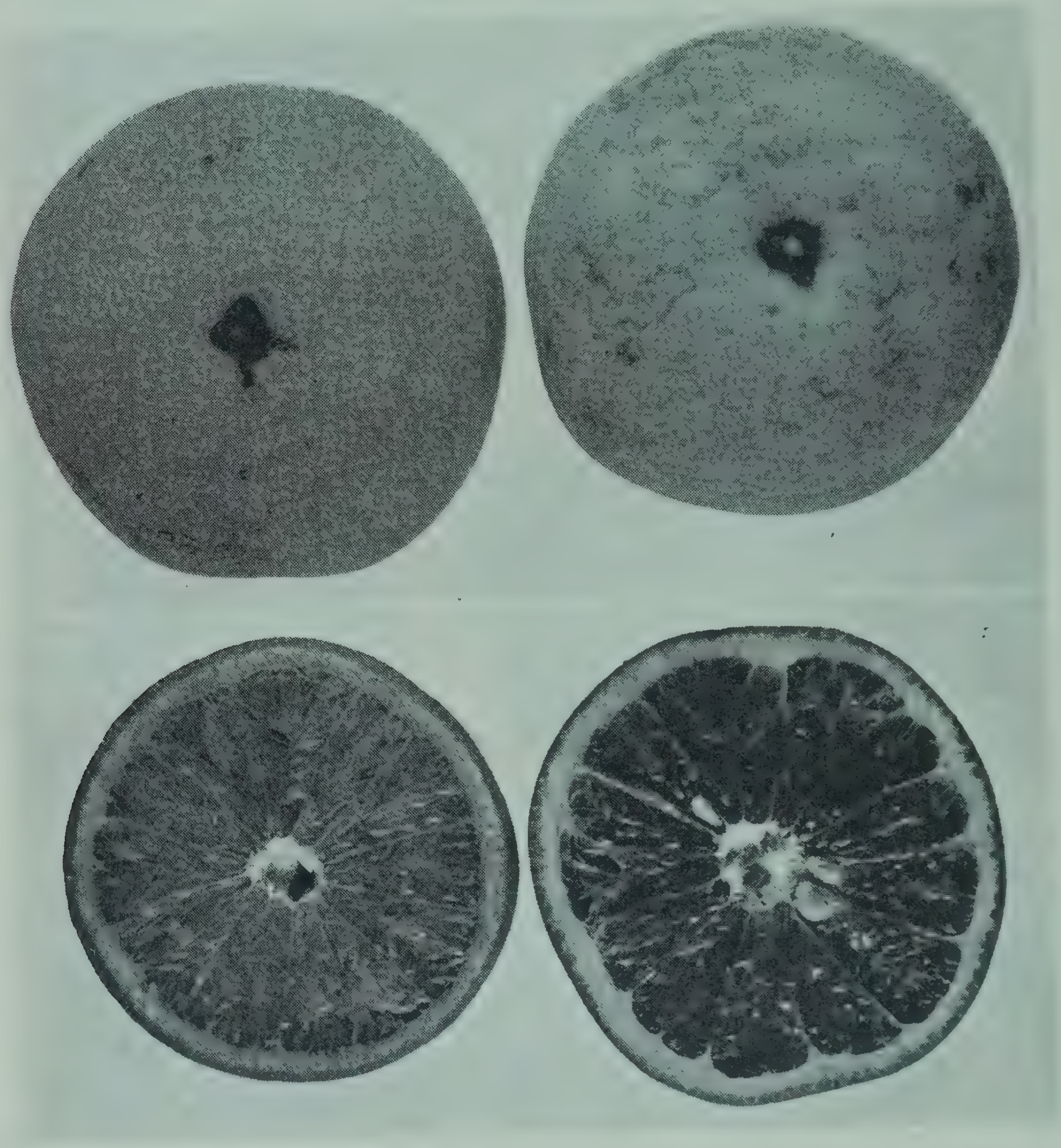

Fig. 4.—Silver Cluster grapefruit after two months' storage at 32°F., showing soggy breakdown (left) both whole and in cross-section. Right, normal fruit with pitted rind. Note the dull soggy appearance of rind and pulp in comparison with normal fruit.

Soggy breakdown is another of the physiological disorders encountered in the cold storage of citrus fruits. The rind at first appears to be water-soaked and the color slightly paled. The albedo (inner rind) becomes soft and soggy, taking on a yellowish color and later is thoroughly water-soaked. In severe cases the locular walls, central axis and pulp become soggy. The oil from the oil glands of the rind penetrates through all of the other tissues, giving a resinous odor and taste to the fruit. It spreads rapidly and appears to be closely related to the respiratory and transpiratory systems (Fig. 4).

Internal Breakdown and Bruising.—A high percentage of internal breakdown results from bulge-pack bruising. Fruits are injured in pressing down the lids of packing boxes when the fruit is bulge-packed. Bruised fruit is more subject to decay than sound fruit, owing to the ease of entrance of fungous organisms. Even though no secondary infection should occur, a physiological breakdown occurs in the bruised portion with excessive drying out of the juice sacs (Fig. 5).

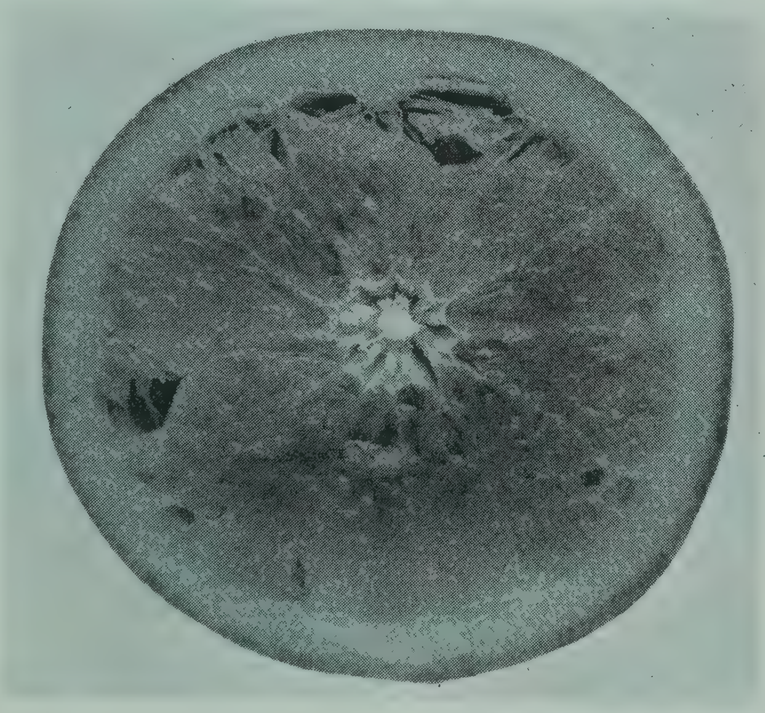

Fig. 5.—Cross-section of Marsh Seedless grapefruit after three months' storage at 37½°F., showing internal breakdown due to pressure in packing.

Stem-end rot is the term applied to fruit showing at first an almost imperceptible discoloration around the button with a slight abnormal degree of pliability soon followed by a leathery, pliable condition and a drab to brown, translucent, watery discoloration of the surface of the rind. There has been no effort made to distinguish between stem-end rots caused by *Diplodia natalensis* and *Phomopsis citri*, as the rots caused by them cannot with certainty be distinguished without pure culture tests (Fig. 6).

Blue mold is the term applied to the disease of those citrus fruits showing either blue-contact mold (*Penicillium italicum*) or the common green mold (*Penicillium digitatum*). It is a soft, watery decay which starts as a discoloration on the surface of the fruit and later involves the entire fruit which becomes a soft shrunken mass covered with a layer of blue or green powdery spores.

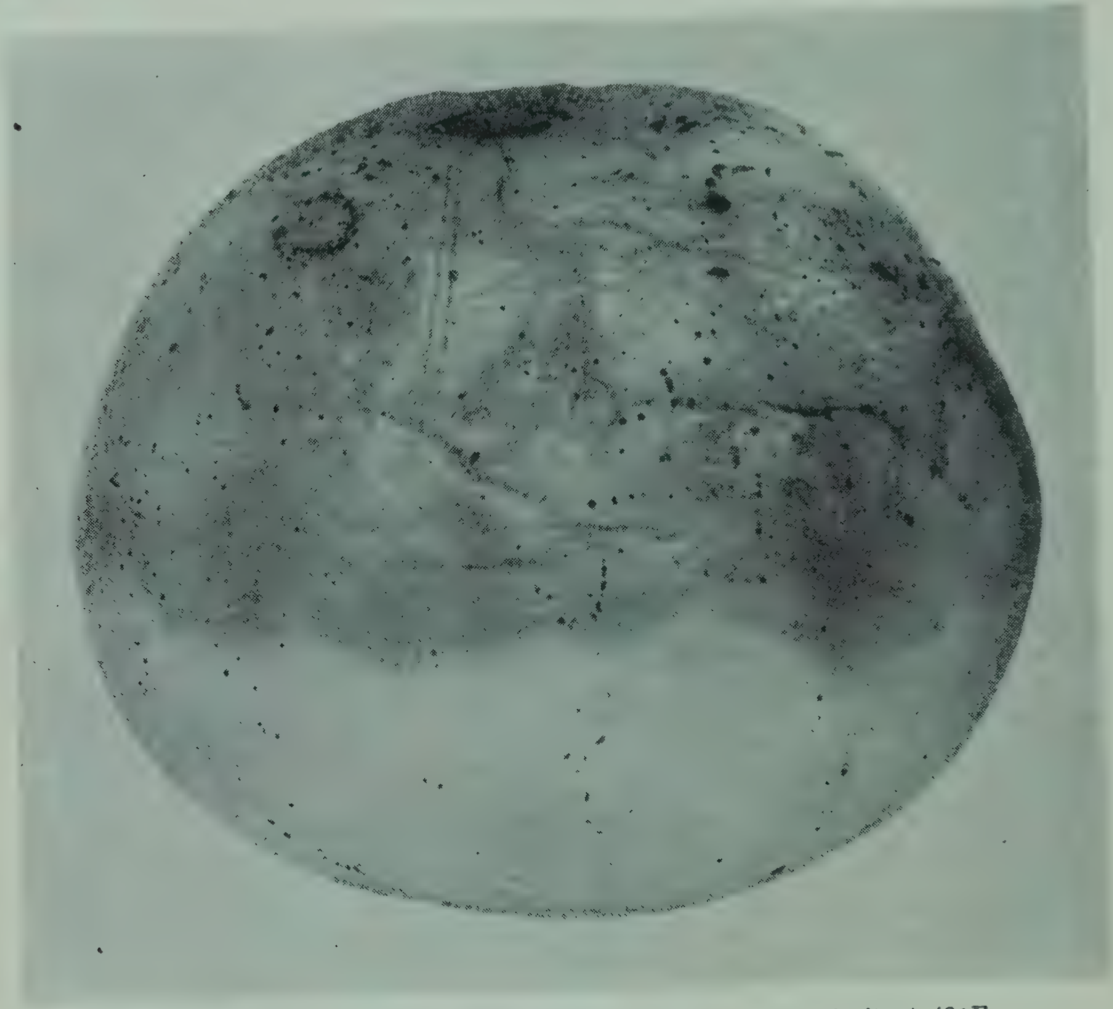

Fig. 6.—Stem-end rot fungus (*Phomopsis citri*) on grapefruit at 42°F. (From Bull. 229.)

Nesting is a term applied to the condition occurring in packed boxes of fruit during storage. The organism from one infected fruit will spread to all of the fruits in contact with it, thus forming a group or nest of infected fruit within the box. It usually occurs in unwrapped fruit or fruit wrapped in wrappers which allow passage of mycelium and spores and which break down and tear when moistened. This can easily be prevented by using wrappers which will stand up under cold storage conditions.

WRAPPERS USED IN THE EXPERIMENT

The following wrappers were used in these experiments:

1. **Ordinary fruit wrap tissue.** This is the common paper ordinarily used for wrapping citrus fruits in Florida. It has a basic weight of 10½ pounds. (By basic weight is meant the weight of one ream of standard size and standard number of sheets adopted by the trade.) It is designated hereafter in this work as "tissue".

2. **White dry waxed paper.** This paper is lightly impregnated but not heavily coated with paraffin. It has a basic weight of 25 pounds. It is designated hereafter as "waxed" paper.

3. **Household waxed paper.** This is a waxed paper of the quality commonly used for household purposes. It has a basic weight of 25 pounds. It is designated hereafter as "household waxed".

4. **Wet waxed paper.** This is a wet waxed paper with a basic weight of 25 pounds. It is designated hereafter as "wet waxed paper".

5. **Genuine vegetable parchment.** This paper is ordinarily prepared by treating sulfite paper for a few seconds with 78 percent sulfuric acid. It is pure white in color, free from taste, will not go to pieces when wet, and has a basic weight of 20 pounds. It is designated hereafter in this work as "parchment".

6. **Prosperity parchment paper.** This is a waterproofed parchment-like paper. It has a basic weight of 25 pounds. It is designated hereafter as "Prosperity parchment".

7. **White eagle parchment paper.** This is a semi-waterproof parchment-like paper. It has a basic weight of 25 pounds. It is designted hereafter as "white eagle parchment".

8. **Green whalehide.** This is a special water-indestructible paper, not quite so fine as parchment, which is used extensively as a crate liner for vegetables. It has a basic weight of 20 pounds, and is hereafter designated as "whalehide".

9. **Manila crown-oil fruit wrap.** This is a paper containing approximately 17 percent neutral oil. It is claimed that the oil closes the pores in the paper and absorbs some of the respiration gases. The paper has a basic weight of 14 pounds, and hereafter in this work it is designated as "oiled" paper.

10. **White chemically-treated wrapper.** This paper contains 1.4 percent copper in the form of copper sulfate. It has a basic weight of 14 pounds, and is designated hereafter in this work as "white chemical 14 pound" paper.

11. **Pink chemically-treated wrapper.** This paper contains the same amount of copper as the white paper described above, but its basic weight is only 10½ pounds. It is designated hereafter in this work as "pink chemical 10 pound" paper.

12. **No. 300 moistureproof cellophane.** This paper is transparent, and many more times resistant to the passage of moisture vapor than plain transparent cellophane. It is designated hereafter as "M. T. cellophane".

13. **No. 300 plain transparent cellophane.** This material possesses no extra moistureproof qualities, but is very similar in appearance to M. T. cellophane except it is of much thinner gauge. It is designated hereafter as "P. T. cellophane".

14. **No. 300 S. S. T. or intermediate cellophane.** This wrap possesses no extra moistureproof qualities, but is intermediate in this respect between M. T. and P. T. cellophane. It is very similar in appearance to M. T. cellophane. It flakes badly when wet. It is designated hereafter as "S. S. T. cellophane".

15. **No. 300 S. A. T. cellophane.** This wrap is an improved type of S. S. T. cellophane. It has the same qualities and is an intermediate grade with respect to moisture retentiveness, but will stand up much longer under storage conditions. It does not flake off when wet. It will be designated hereafter as "S. A. T. cellophane".

16. **No. 88 regular kodapak.** This is a transparent wrap very similar to the P. T. cellophane wrap with about the same qualities and same moisture-vapor retentiveness. It will be designated hereafter in this work as "regular kodapak".

17. **No. 88 moistureproof kodapak.** This is a transparent moistureproof wrap very similar to the M. T. cellophane in quality and moisture-vapor retentiveness. It will be designated hereafter in this work as "moistureproof kodapak".

18. **No. 300 plain white moistureproof sylphrap.** This is a transparent moistureproof wrap very similar to the M. T. cellophane in quality and moisture-vapor retentiveness. It will be designated hereafter in this work as "moistureproof sylphrap".

19. **Plain aluminum foil gauge .00065″.** This is a smooth aluminum foil wrap, technically designated as grade 2 So, and packed tissue-interleaved to permit ease of separating sheets for wrapping, or to be used as a liner to the foil. It is designated hereafter as "plain aluminum 65".

20. **Plain aluminum foil gauge .00045″.** This is a thinner foil than the .00065″ aluminum, but is also of the 2 So grade, and is

similarly packed tissue-interleaved. It is designated hereafter in this work as "plain aluminum 45".

21. **Embossed aluminum foil gauge .00065″.** This foil is of the same weight and gauge as the plain aluminum 65, but is embossed with the factory pattern "F". It is also grade 2 So, and is packed tissue-interleaved. It is designated hereafter in this work as "embossed aluminum 65".

EXPERIMENTS WITH ORANGES

All of the fruit used in this work consisted of sweet, or round oranges (*Citrus sinensis*). Two varieties only were used—Pineapple and Valencia—except in supplementary experiments. Several series of fruit were stored successively over a period of years. All of the fruit of one variety came from trees of the same age having had the same cultural treatment. It was not colored or treated in any manner except the washing, grading and sizing, common to Florida packinghouses. The fruit was wrapped at ordinary temperatures and placed in rows on slatted shelves in such a position that each fruit had free circulation of air surrounding it, or packed in boxes using the commercial sizes and packing diagrams. Individual fruits with wrappers were weighed to a tenth of a gram and the weights of those for each type of wrapper were averaged. At regular intervals all fruits on the shelves and in the boxes were examined for pitting, decay, keeping quality and taste, and at the same time a number of fruits from each combination of wrapper and temperature were removed to ordinary temperatures (70°-80° F.) of the retail store. At regular intervals a part of this fruit was unwrapped and its keeping quality after removal from storage was determined by observing pitting, decay, general appearance and any effect that the various wrappers may have had on taste of the fruit.

PINEAPPLE ORANGES

The work with the Pineapple oranges consisted of a comparison of 13 different wrappers at six different temperatures, 32°, 37½°, 42°, 48°, 54° and 58° F. The fruit was wrapped in three different grades of cellophane (moistureproof, semimoistureproof and non-moistureproof), three different grades of aluminum foil (plain gauge .00045, plain gauge .00065 and embossed gauge .00065), two kinds of copper sulfate treated paper wraps (white chemical 14 pound and pink chemical 10

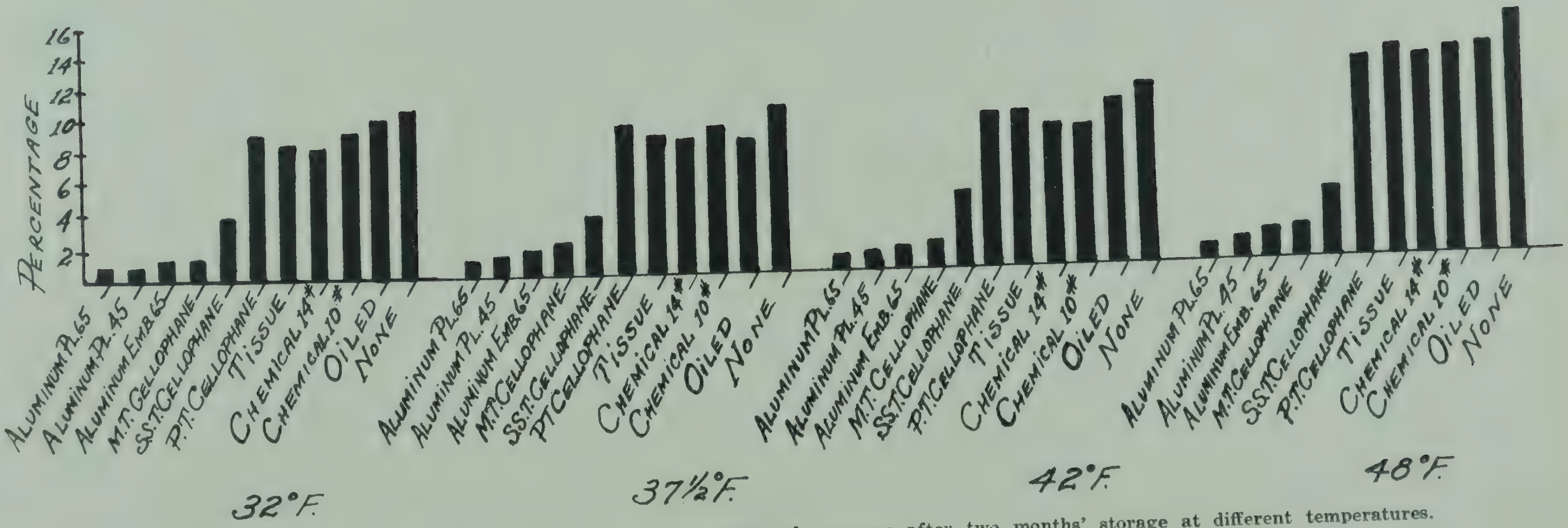

Fig. 7.—Relative effect of wrappers on loss in weight of Pineapple oranges after two months' storage at different temperatures.

pound), and waxed, oiled, parchment and tissue papers. One lot was also stored unwrapped as a check. Supplementary experiments were carried on from time to time to augment information from the main experiments. In all cases the results of the experiments are recorded as numerical data, supplemented by graphs, figures and photographs when possible.

Loss in Weight.—Table 1 gives the percentage loss in weight of the differently wrapped fruits at each storage temperature. The figures indicate the moistureproof wrappers (aluminum foils and moistureproof cellophane) were much superior to the paper wraps. All of the aluminum foils and M. T. cellophane proved very efficient in regard to moisture retentiveness and prevention

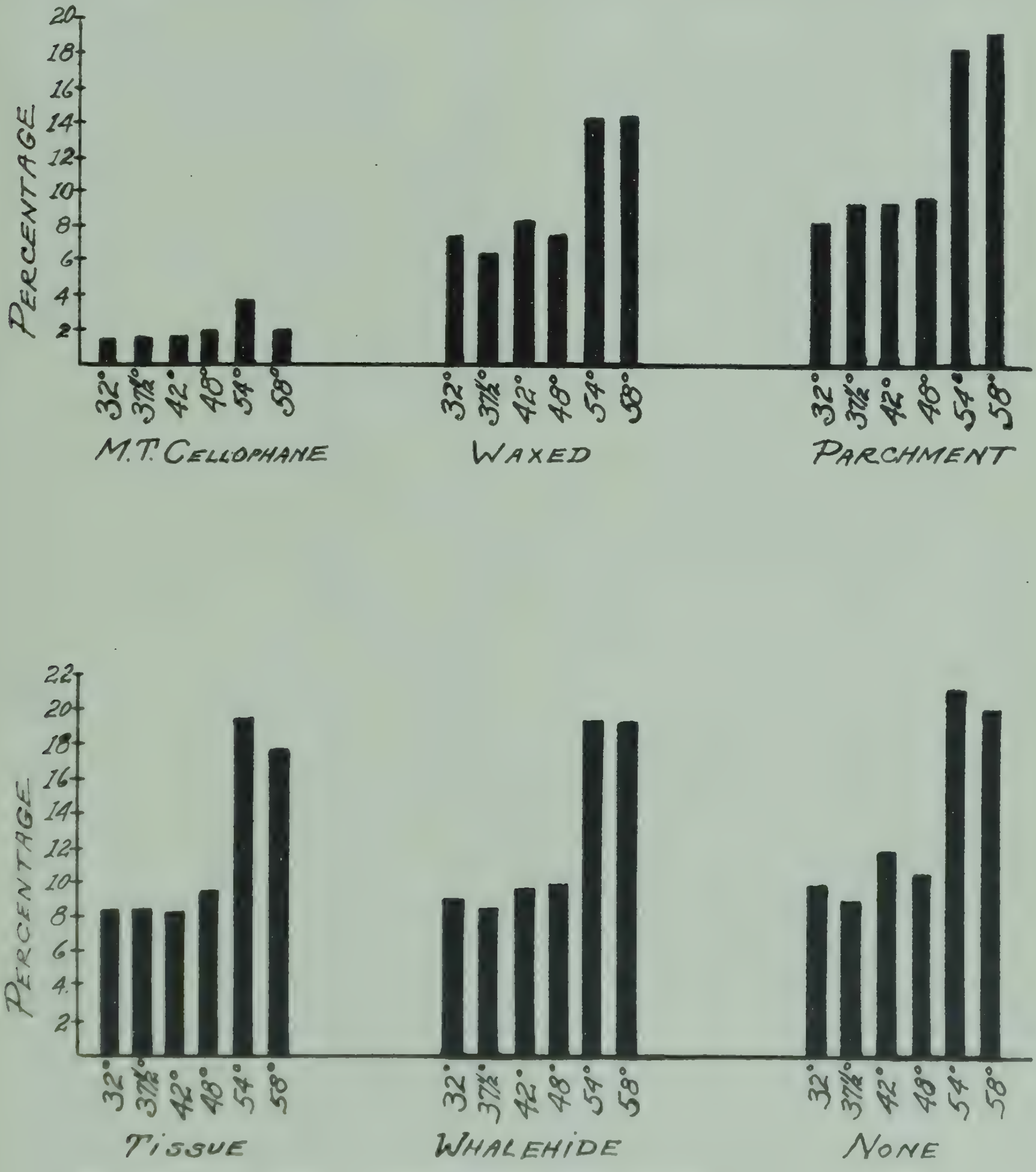

Fig. 8.—Relative effect of temperature on loss in weight of Pineapple oranges in various wrappers.

TABLE 1.—THE EFFECT OF VARIOUS WRAPPERS AND TEMPERATURE ON THE LOSS IN WEIGHT OF PINEAPPLE ORANGES IN STORAGE. (EACH FIGURE IS AVERAGE OF NOT LESS THAN 25 FRUITS.)

Temp.	Wrapper	Percentage loss in weight after			
		1 Month	2 Months	3 Months	4 Months
32°F.	Plain aluminum 45	0.4	0.8	1.0	1.5
	Plain aluminum 65	0.6	0.9	1.2	1.5
	Embossed aluminum 65	0.6	1.1	1.4	1.9
	M. T. cellophane	0.6	1.2	1.8	2.3
	S. S. T. cellophane	2.2	3.9	5.5	7.2
	Waxed	3.8	7.4	10.7	----
	Parchment	4.4	8.3	11.9	----
	Tissue	4.6	8.6	12.6	----
	White chemical 14 lb.	4.7	8.6	------	----
	Whalehide	4.8	9.0	12.8	----
	Pink chemical 10 lb.	5.3	9.1	------	----
	Oiled	5.2	9.2	------	----
	P. T. cellophane	5.2	9.2	11.9	16.2
	None	5.6	10.3	14.1	----
	Average	3.4	6.3	7.7	5.1
37½°F.	Plain aluminum 65	0.5	0.8	1.1	1.3
	Plain aluminum 45	0.7	1.0	1.2	1.5
	Embossed aluminum 65	0.9	1.3	1.7	2.2
	M. T. cellophane	0.8	1.6	2.5	3.4
	S. S. T. cellophane	1.9	3.5	4.8	8.4
	Waxed	3.2	6.5	9.8	----
	Whalehide	4.4	8.4	12.4	----
	White chemical 14 lb.	4.8	8.4	------	----
	Tissue	4.8	8.7	13.1	----
	Oiled	5.1	8.5	------	----
	Parchment	4.6	9.1	13.8	----
	Pink chemical 10 lb.	5.1	9.2	------	----
	P. T. cellophane	5.3	9.4	12.7	16.6
	None	5.1	9.6	13.8	----
	Average	3.4	6.1	7.9	5.6
42°F.	Plain aluminum 65	0.4	0.8	1.0	1.2
	Plain aluminum 45	0.4	0.9	1.1	1.4
	Embossed aluminum 65	0.6	1.2	1.6	2.1
	M. T. cellophane	0.6	1.6	2.6	3.5
	S. S. T. cellophane	2.4	4.9	7.1	9.4
	Waxed	4.2	8.2	12.0	----
	Pink chemical 10 lb.	4.4	8.9	------	----
	White chemical 14 lb.	4.5	9.0	------	----
	Tissue	4.6	9.1	12.3	----
	Parchment	5.0	9.4	13.7	----
	P. T. cellophane	5.0	9.9	13.9	17.9
	Whalehide	5.1	9.9	14.5	----
	Oiled	5.0	10.3	------	----
	None	6.2	11.6	16.9	----
	Average	3.5	6.8	8.8	5.9

TABLE 1.—THE EFFECT OF VARIOUS WRAPPERS AND TEMPERATURE ON THE LOSS IN WEIGHT OF PINEAPPLE ORANGES IN STORAGE. (EACH FIGURE IS AVERAGE OF NOT LESS THAN 25 FRUITS.)—*Continued.*

Temp.	Wrapper	Percentage loss in weight after			
		1 Month	2 Months	3 Months	4 Months
48°F.	Plain aluminum 65	0.5	0.9	1.3	1.6
	Plain aluminum 45	0.5	1.1	2.5	2.8
	Embossed aluminum 65	0.8	1.8	2.4	3.2
	M. T. cellophane	0.6	2.0	3.0	4.5
	S. S. T. cellophane	2.0	4.2	6.2	8.7
	Waxed	3.3	7.6	11.5	....
	Parchment	4.6	9.7	14.6	....
	Whalehide	4.5	10.0	15.5	....
	Tissue	5.7	11.5	14.8	....
	White chemical 14 lb.	6.5	12.9	15.4	....
	P. T. cellophane	6.5	12.8	......	....
	None	6.4	12.9	......	....
	Pink chemical 10 lb.	6.8	13.2	......	....
	Oiled	6.9	13.6	......	....
	Average	4.0	8.2	8.7	4.2

of loss in weight during storage. The S. S. T. cellophane, an intermediate grade, was next best, while the waxed paper was the most efficient paper wrapper. P. T. cellophane, whalehide and oiled and chemically treated papers were no more efficient than ordinary tissue wraps in prevention of loss in weight during storage (Fig. 7).

The chemical wrappers varied in relative efficiency at different temperatures but this variance was not appreciable, fruit in both wrappers losing approximately the same weight and almost as much as that which was unwrapped. The difference among wraps and the superiority of the moistureproof wraps in preventing loss in weight became even more accentuated as the length of storage increased.

Concerning temperature effect, as a general rule fruit lost more weight at higher temperatures than at lower ones (Fig. 8). The relationship was direct in that as the temperature increased the loss in weight from the fruit increased. As a general rule the loss of weight of the fruit held at 32° F. was about the same or only slightly less than that held at 37½° F. This was probably due to the freezing out of moisture in the air, making it difficult to maintain a high relative humidity at temperatures as low as 32° F.

Table 2 gives the average percentage loss in weight of the four lowest temperatures for the various wrappers. The figures of Table 2 bring out even more clearly than do those of Table

1 the marked superiority of the aluminum foil and moistureproof cellophane wraps over the paper wraps and the value of the various paper wraps in preventing loss in weight during storage (Fig. 8). A comparison of the effect of various wrappers on general appearance of the fruit after three months' storage at different temperatures is shown in Figs. 10 and 11 and the loss in weight after two months' storage in Fig. 9.

TABLE 2.—AVERAGE LOSS IN WEIGHT OF PINEAPPLE ORANGES FROM ALL STORAGE TEMPERATURES* IN THE VARIOUS WRAPPERS.

Wrapper	Percentage loss in weight after			
	1 Month	2 Months	3 Months	4 Months
Plain aluminum 65	.5	.9	1.2	1.4
Plain aluminum 45	.5	1.0	1.5	1.8
Embossed aluminum 65	.7	1.4	1.8	2.4
M. T. cellophane	.7	1.6	2.5	3.4
S. S. T. cellophane	2.1	4.1	5.9	8.4
Waxed	3.6	7.4	11.0	....
Parchment	4.7	9.1	13.5	....
Tissue	4.9	9.5	13.2	....
White chemical 14 lb.	5.1	9.7	15.4	....
Whalehide	4.7	9.3	13.8	....
Pink chemical 10 lb.	5.4	10.1	......	....
Oiled	5.6	10.4	......	....
P. T. cellophane	5.5	10.3	12.8	16.9
None	5.8	11.3	14.9	....
Average	3.6	6.9	9.0	5.7

*Average of 32°, 37½°, 42° and 48°F.

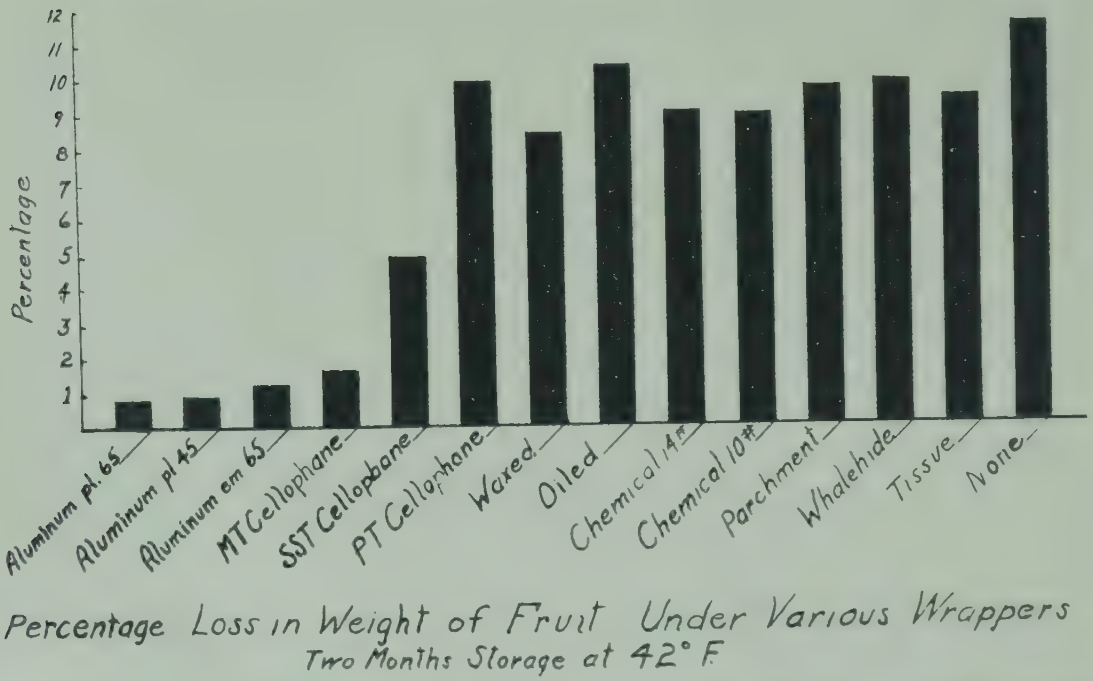

Fig. 9.—Average percentage loss in weight of all of the Pineapple oranges wrapped in the various wrappers.

Pitting.—The pitting tabulations were made by recording the number of fruits in each sample showing (a) no pitting, (b) slight pitting, (c) moderate pitting and (d) bad pitting. In order to present the data in less complicated form, arbitrary score values were assigned to the above classes as follows:

No pitting	100 points
Slight pitting	80 points
Moderate pitting	60 points
Bad pitting	40 points

The sum of the individual scores was divided by the number of fruit examined to obtain the average score of the sample.

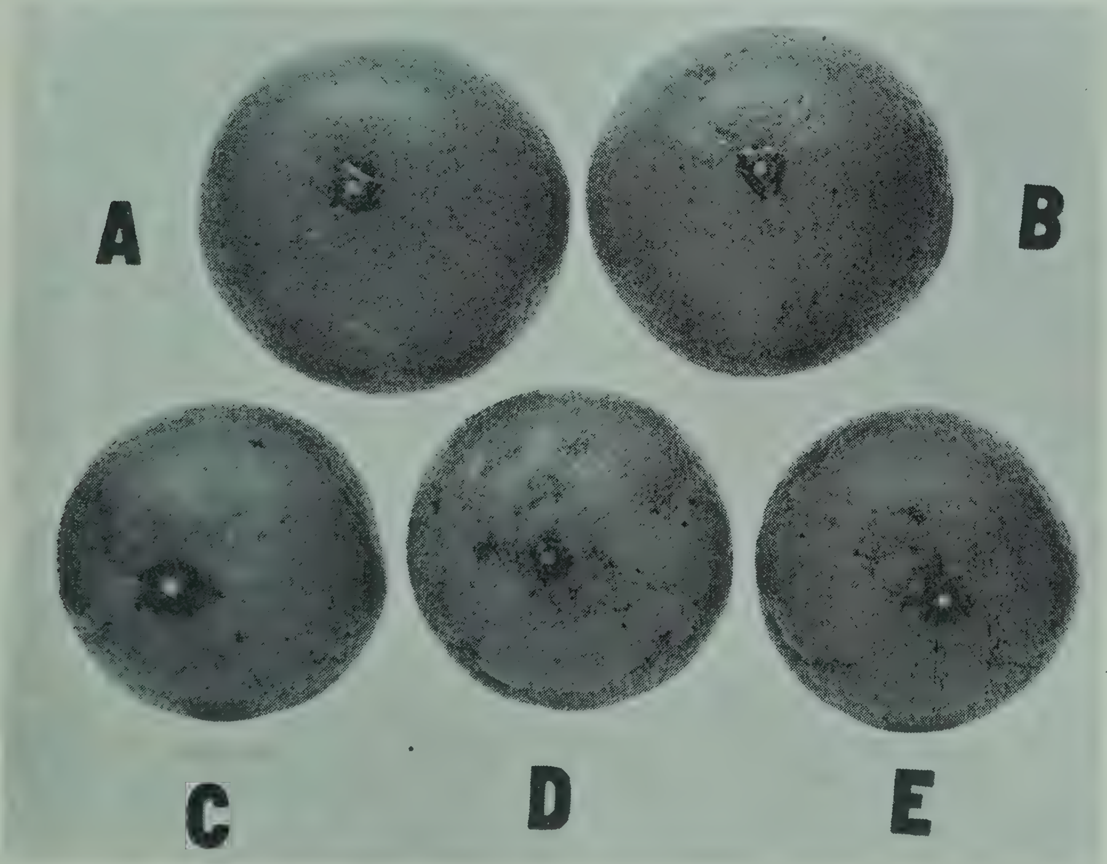

Fig. 10.—Typical Pineapple oranges after three months' storage at 42°F., wrapped in (A) plain aluminum 45, (B) moistureproof cellophane, (C) no wrapper, (D) white chemical 14 lb., and (E) P. T. cellophane. (Cf. Fig. 11.)

Data showing the effect of wrappers on the pitting of Pineapple oranges are presented in Table 3. For the four months' period the S. S. T. cellophane showed up better than any other. The oiled and waxed papers were next best, while the other cellophane wraps and aluminum wraps were about the same. Tissue wraps had little or no effect on pitting. Fruit in the other paper wraps averaged significantly less pitting during the two months' period than did the unwrapped fruit.

TABLE 3.—EFFECT OF VARIOUS WRAPPERS ON THE PITTING OF PINEAPPLE ORANGES. (AVERAGE OF ALL FRUITS AT FOUR TEMPERATURES: 32°, 37½°, 42° AND 48° F.)

Wrapper	One Month's Storage Days After Removal				Two Months' Storage Days After Removal				Three Months' Storage Days After Removal				Four Months' Storage Days After Removal				Average for All Storage Periods Days After Removal			Absolute Average Fruit Score
	1	3	5	Avg.	1	3	5	Avg.	1	3	5	Avg.	1	3	5	Avg.	1	3	5	All Examinations
S. S. T. cellophane	94	92	88	91	83	73	67	74	65	72	60	66	55	63	62	60	74	75	69	73
Waxed	....	72	77	74	70	75	68	71	67	67	58	64	73	62	....	68	77	70	62	70
Embossed aluminum 65	94	87	87	89	65	60	70	65	53	58	67	59	53	65	52	57	66	68	69	68
M. T. Cellophane	82	75	83	80	77	67	63	69	66	63	61	63	61	62	60	61	70	66	67	68
Plain aluminum 45	90	82	85	86	72	67	62	67	60	58	57	58	63	58	50	57	71	66	64	67
Plain aluminum 65	87	85	72	81	78	65	80	74	67	55	60	61	60	50	50	53	73	64	65	67
Whalehide	....	87	70	78	72	68	60	67	70	55	57	61	63	58	....	60	70	68	62	67
Parchment	....	75	65	70	80	68	62	70	75	65	60	67	62	53	....	58	72	65	60	66
P. T. cellophane	83	82	78	81	67	57	53	59	52	58	52	54	50	45	50	48	63	60	58	60
Oiled[1]	80	78	77	78	72	60	60	64	....	....	....	....	....	....	....	....	76	69	68	71
White chemical 14 lb.[1]	92	68	75	78	67	62	50	60	....	....	....	....	....	....	....	....	79	65	62	69
Pink chemical 10 lb.[1]	95	67	70	77	63	62	50	58	....	....	....	....	....	....	....	....	79	65	60	68
None[1]	82	71	60	70	63	62	55	60	....	....	....	....	....	....	....	....	68	66	55	63
Tissue[1]	85	64	63	66	61	55	51	56	....	....	....	....	....	....	....	....	67	58	57	61

[1] Observations made for 2 months only.

Score values:	No pitting	100
	Slight pitting	80
	Moderate pitting	60
	Bad pitting	40

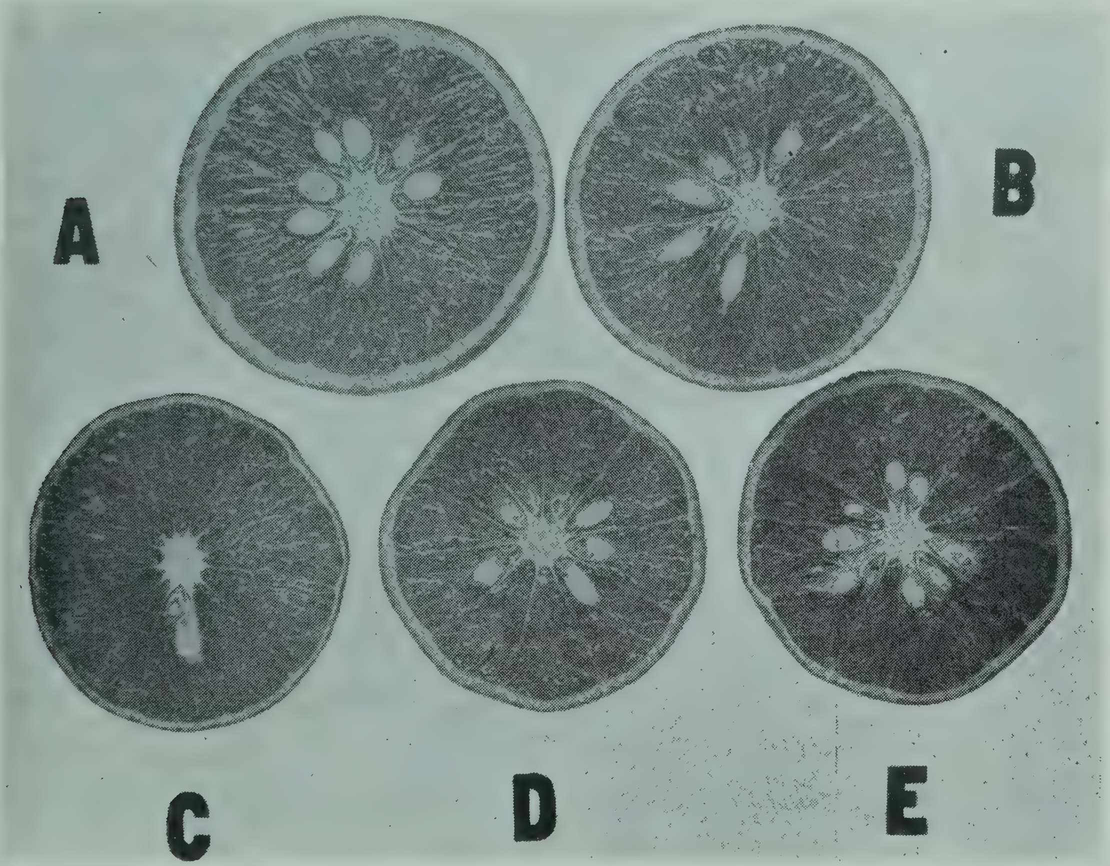

Fig. 11.—Cross-section view of fruits shown in Fig. 10. (A) Plain aluminum 45, (B) moistureproof cellophane, (C) no wrapper, (D) white chemical, and (E) P. T. cellophane.

The amount of pitting on fruits removed from storage increased at a faster rate on fruit wrapped with the paper wraps than on that wrapped with the moistureproof cellophane and aluminum foil, but the difference was not appreciable. Pitting gradually became worse as the storage period increased and as the number of days the fruit was kept after removal from storage increased. The increase in the latter case, however, was not very great (Fig. 3).

Table 4 contains figures for the relative effects of different temperatures on pitting of Pineapple oranges in storage. The figures show that pitting decreases as temperature increases. The storage temperature, however, apparently had no appreciable effect on the increase of pitting after the fruit was removed from storage.

General Appearance.—Firmness, wrinkling, drying out, pitting, and color were all taken into consideration in judging the fruit for its general appearance. A fruit was classed as (1) good, when it could not be distinguished in appearance from a fresh fruit; (2) fair, when it was still marketable but somewhat inferior in quality to fresh fruit, and (3) bad, when it was no

TABLE 4.—EFFECT OF DIFFERENT TEMPERATURES ON THE PITTING OF PINEAPPLE ORANGES WRAPPED IN VARIOUS WRAPPERS. (AVERAGE OF 6 WRAPPERS.)[1]

Temperature	One Month's Storage Days After Removal				Six Weeks' Storage Days After Removal				Two Months' Storage Days After Removal				Three Months' Storage Days After Removal				Average for the Four Storage Periods—Days After Removal			Absolute Average Fruit Score All Examinations
	1	3	5	Avg.	1	3	5	Avg.	1	3	5	Avg.	1	3	5	Avg.	1	3	5	
32°F.	....	72	64	68	65	68	58	64	68	61	56	62	56	66	....	61	64	67	59	63
37½°F.	....	69	64	66	73	70	61	68	59	56	60	58	60	57	....	58	64	64	61	63
42°F.	....	77	80	78	75	77	60	71	77	60	59	65	66	50	....	58	76	66	62	68
48°F.	....	79	69	74	78	69	75	74	76	76	67	73	81	66	....	73	79	65	66	70
Avg.	....	74	69	72	73	71	64	69	70	63	60	64	66	60	....	62	71	66	62	....
54°F.	....	80	72	76	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
58°F.	....	78	76	77	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Room	....	80	72	76	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

---

[1] Waxed, M. T. cellophane, whalehide, parchment, tissue and none.

Score values:		
	No pitting	100
	Slight pitting	80
	Moderate pitting	60
	Bad pitting	40

longer marketable. A similar method of scoring to that used for pitting was applied to simplify the data. The arbitrary score values assigned were as follows:

Good	100 points
Fair	70 points
Bad	0 points

The sum of the individual scores was divided by the number of fruit examined to obtain the average score of the sample.

An examination of Table 5 shows that the aluminum foils, moistureproof cellophane and S. S. T. cellophane proved much better than any of the other wrappers in preserving good general appearance of the fruit. Waxed paper ranked best of the paper wraps, but the other paper wraps showed little significant advantage over plain ordinary tissue wraps. The P. T. cellophane, oiled paper, and chemically treated wrappers showed little significant advantage over no wrapper at all and in some cases had a much poorer appearance. The P. T. cellophane was of no value by the end of the second month. M. T. cellophane kept the fruit in firmer condition, but less pitting developed in the fruit

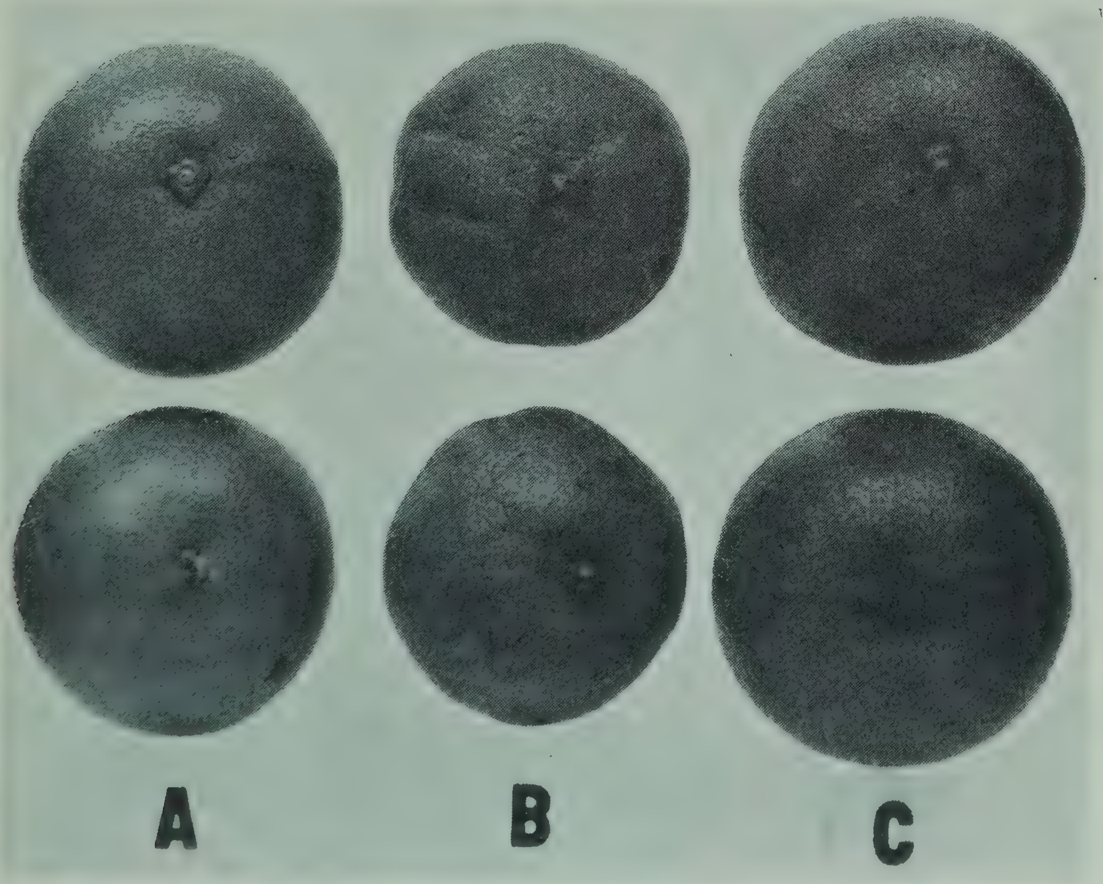

Fig. 12. Typical Pineapple oranges stored three months at 42°F., wrapped in (A) S. S. T. cellophane (medium grade), (B) P. T. cellophane (thin grade), and (C) M. T. cellophane (heavy grade).

TABLE 5.—RELATIVE EFFECT OF VARIOUS WRAPPERS ON GENERAL APPEARANCE OF THE PINEAPPLE ORANGES. (AVERAGE OF FOUR TEMPERATURES, 32°, 37½°, 42° AND 48° F.)

Wrapper	One Month's Storage Days After Removal				Two Months' Storage Days After Removal				Three Months' Storage Days After Removal				Average for All of the Storage Periods Days After Removal			Absolute Average Fruit Score
	1	3	5	Avg.	1	3	5	Avg.	1	3	5	Avg.	1	3	5	All Examinations
Plain aluminum 65	100	98	93	97	93	79	65	79	51	46	22	40	81	74	60	72
M. T. cellophane	98	96	70	88	87	65	73	75	48	38	....	43	78	66	72	69
S. S. T. cellophane	100	98	92	97	84	74	35	64	46	54	38	46	77	75	55	69
Embossed aluminum 65	100	98	98	99	82	57	63	67	28	37	45	37	70	64	69	68
Plain aluminum 45	100	100	100	100	95	72	52	73	31	25	31	29	75	66	61	67
Waxed	....	85	82	84	67	59	51	59	40	28	....	34	54	57	67	59
Parchment	....	90	62	76	65	43	32	47	12	17	....	15	39	50	47	46
Whalehide	....	78	60	69	79	32	29	47	17	12	....	15	48	41	45	44
Tissue	52	51	55	53	29	21	13	21	23	6	....	15	35	26	23	30
White chemical 14 lb.	64	47	35	48	0	0	0	0	....	....	....	....	32	24	18	25
Oiled	38	64	35	46	6	0	0	2	....	....	....	....	21	32	18	24
None	23	50	36	36	26	18	15	20	20	12	....	16	23	27	17	24
Pink chemical 10 lb.	60	35	23	39	0	0	0	0	....	....	....	....	30	18	12	20
P. T. cellophane	69	64	41	58	6	0	0	2	0	0	0	0	19	16	10	15

Score Value:
Good .... 100 points
Fair .... 70 points
Bad .... 0 points

wrapped in the S. S. T. cellophane. The data show very little difference between the embossed and plain aluminum foils in this regard. Figure 12 gives a comparison of the three grades of cellophane as wraps for Pineapple oranges at 42° F. after three months.

TABLE 6.—DECAY OF PINEAPPLE ORANGES AT VARIOUS TEMPERATURES IN DIFFERENT WRAPPERS AT ONE MONTH INTERVALS.

Wrapper	32°	37½°	42°	48°	54°	58°	Total	Stem-End Rot	Penicilium
				One Month					
Plain aluminum 65	0	0	0	0	..	..	0	0	0
Plain aluminum 45	0	0	0	0	..	..	0	0	0
Embossed aluminum 65	0	0	0	0	..	..	0	0	0
Oiled	0	0	0	0	..	..	0	0	0
Pink chemical 10 lb.	0	0	0	1	..	..	1	0	1
White chemical 14 lb.	0	0	0	2	..	..	2	0	2
S. S. T. cellophane	0	0	0	3	..	..	3	2	1
P. T. cellophane	0	0	0	0	..	..	0	0	0
M. T. cellophane	0	0	0	1	..	..	1	0	1
Waxed	0	0	2	3	11	11	27	25	2
Whalehide	0	0	0	1	6	15	22	21	1
Parchment	0	0	0	0	4	14	18	16	2
Tissue	0	0	0	2	9	12	23	19	4
None	0	0	1	1	8	9	19	19	0
				Two Months					
Plain aluminum 65	1	0	0	8	..	..	9	7	2
Plain aluminum 45	0	1	0	8	..	..	9	7	2
Embossed aluminum 65	0	0	1	3	..	..	4	4	0
Oiled	0	0	0	6	..	..	6	6	0
Pink chemical 10 lb.	0	0	0	4	..	..	4	4	0
White chemical 14 lb.	0	0	0	3	..	..	3	3	0
S. S. T. cellophane	0	0	1	8	..	..	9	8	1
P. T. cellophane	0	0	0	2	..	..	2	2	0
M. T. cellophane	0	0	1	9	..	..	10	10	0
Waxed	0	1	0	8	4	3	16	15	1
Whalehide	0	1	1	7	14	12	35	34	1
Parchment	0	1	0	7	12	0	20	20	0
Tissue	0	0	0	8	6	6	20	20	0
None	0	0	0	7	6	4	17	17	0
				Three Months					
Plain aluminum 65	0	0	4	3	..	..	7	6	1
Plain aluminum 45	0	3	3	8	..	..	14	10	4
Embossed aluminum 65	0	1	0	2	..	..	3	2	1
S. S. T. cellophane	0	0	5	2	..	..	7	7	0
P. T. cellophane	0	0	3	6	..	..	9	8	1
M. T. cellophane	0	0	10	7	..	..	17	10	7
Waxed	0	5	8	4	1	0	18	17	1
Whalehide	0	2	2	8	3	2	17	17	0
Parchment	0	1	4	7	4	3	19	19	0
Tissue	0	1	6	5	0	3	15	15	0
None	0	0	4	8	0	2	14	14	0

There was considerable falling off in quality as the storage period increased. This was due more to pitting than to any other cause, except in the P. T. cellophane and some of the paper wraps and no wrap where drying out was a more important factor in general appearance of fruit.

Very little effect of temperature on general appearance was noted. Fruits at the lower temperatures pitted too badly to have a good appearance and those at the higher temperatures had excessive drying out and decay. There was practically no difference in general appearance of the fruit held at 32°, 37½°, 42°, and 48°.

Decay.—The only appreciable decay encountered during the course of the experiment with oranges was of two types, Penicillium mold and stem-end rot. Both green (*Penicillium italicum*) and blue mold (*Penicillium digitatum*) were encountered, and both *Phomopsis citri* and *Diplodia natalensis*, organisms causing stem-end rot, were found.

Table 6 shows the number of fruits decayed at various temperatures at intervals of one month wrapped in the various wrappers. The figures show no great difference among the wrappers, except that there was slightly more decay prevalent as a rule under the moisture-resistant wrappers, but this was not enough to be outstanding.

It is evident from the data, however, that more decay developed at the higher temperatures, and that the amount gradually increased as the storage periods became longer. There was very little decay in the fruit held at 32° and 36° F., and then only after two and three months of storage. The warmer the storage temperature the more the decay. Stem-end rot was the more prevalent of the decays. Very little Penicillium mold was found of either type.

VALENCIA ORANGES

The work with Valencia oranges consisted of a comparison of seven different wrappers and one unwrapped lot. The wrappers were: Plain aluminum 65, M. T. cellophane, waxed, tissue, whalehide, oiled and parchment papers.

Loss in Weight.—The figures of Table 7 show the superiority of aluminum foil and moistureproof cellophane in preventing loss in weight. Waxed paper wraps showed some advantage over the other paper wraps, but fruit in all of the other wraps showed little advantage over that not wrapped and none at all over the ordinary tissue wrap.

TABLE 7.—TOTAL PERCENTAGE LOSS IN WEIGHT OF VALENCIA ORANGES HELD AT VARIOUS TEMPERATURES IN VARIOUS WRAPPERS. (EACH FIGURE IS AVERAGE OF NOT LESS THAN 25 FRUITS.)

Temp.	Wrapper	Percentage Loss in Weight After					
		1 M'th	6 W'ks	2 M'ths	3 M'ths	4 M'ths	5 M'ths
32°F.	Plain aluminum 45	0.2	0.4	0.5	1.0	1.5	1.9
	M. T. cellophane	0.2	0.6	1.0	1.6	2.6	3.2
	Waxed	2.5	3.6	5.9	8.0	....	....
	Oiled	2.6	3.9	6.0	8.3	....	....
	Tissue	2.9	4.4	6.6	9.1	....	....
	None	2.8	4.3	6.6	9.0	....	....
	Whalehide	3.5	5.2	7.9	10.6	....	....
	Average	2.1	3.2	4.9	6.8	2.1	2.6
37½°F.	Plain aluminum 45	0.3	0.5	0.6	1.0	1.5	1.6
	M. T. cellophane	0.4	0.7	1.2	1.9	3.3	3.9
	Waxed	2.5	4.1	6.4	8.6	....	....
	Oiled	3.1	5.2	7.9	10.6	....	....
	Parchment	3.3	5.6	8.4	11.1	....	....
	Tissue	3.4	5.6	8.6	11.6	....	....
	Whalehide	3.4	5.8	8.8	11.8	....	....
	None	3.5	5.8	9.1	13.3	....	....
	Average	2.5	4.2	6.4	8.7	2.4	2.8
42°F.	Plain aluminum 45	0.5	0.6	0.9	1.4	2.2	2.7
	M. T. cellophane	0.5	0.9	1.4	2.2	3.6	4.4
	Waxed	3.7	5.5	8.4	11.9	....	....
	Tissue	4.0	5.9	9.3	13.0	....	....
	Parchment	4.2	6.2	9.6	13.0	....	....
	Whalehide	4.2	6.3	9.8	13.4	....	....
	Oiled	4.4	6.5	10.1	13.9	....	....
	None	4.2	6.3	10.1	14.2	....	....
	Average	3.2	4.8	7.5	10.4	2.9	3.6
48°F.	Plain aluminum 45	0.4	0.6	1.1	1.6	2.4	2.8
	M. T. cellophane	0.5	0.7	1.4	2.0	3.3	4.1
	Waxed	3.1	4.5	7.1	9.6	....	....
	Tissue	4.1	6.0	9.2	12.3	....	....
	Oiled	4.4	6.4	9.9	13.1	....	....
	Whalehide	4.8	6.9	10.6	14.0	....	....
	None	4.9	7.2	11.2	15.1	....	....
	Parchment	5.0	7.5	11.6	15.7	....	....
	Average	3.4	5.0	7.8	10.4	2.9	3.5
58°F.	M. T. cellophane	0.7	1.8	....	....	....	....
	Waxed	6.1	9.8	....	....	....	....
	Oiled	7.3	11.7	....	....	....	....
	Tissue	7.6	12.0	....	....	....	....
	Parchment	7.9	12.5	....	....	....	....
	None	8.8	13.9	....	....	....	....
	Average	6.4	10.3	....	....	....	....

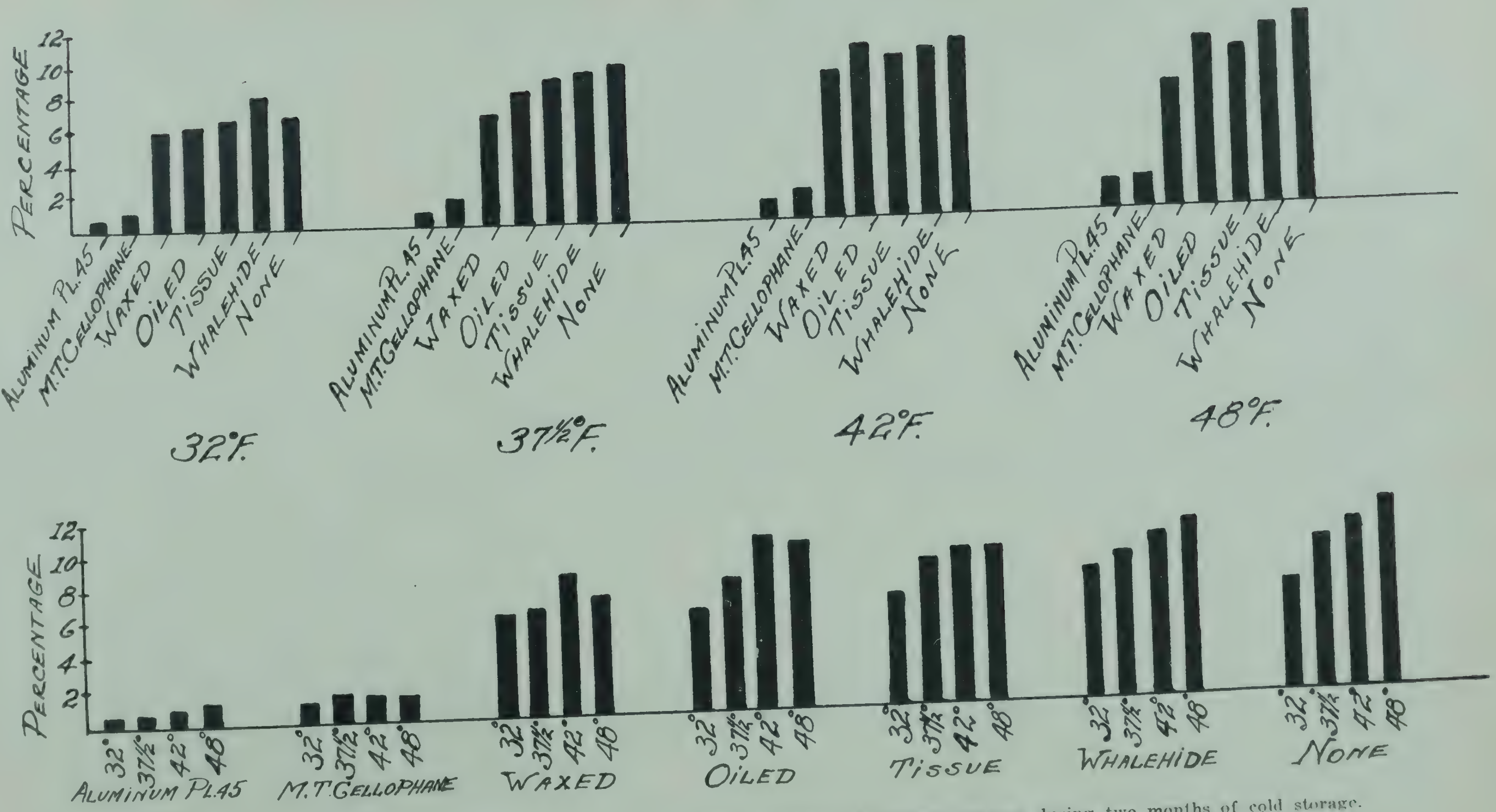

Fig. 13.- Relative effect of temperature and wrappers on loss in weight of Valencia oranges during two months of cold storage.

Wrappers used on both Pineapple and Valencia oranges showed approximately the same relative efficiency.

Table 8 shows the average percentage loss in weight of fruit at the four temperatures—32°, 37½°, 42° and 48° F.—for the various wrappers. The aluminum foil appeared slightly more efficient than the cellophane in reducing loss in weight.

A comparison of the wrappers as to their effect on the loss in weight after two months' storage is shown in Fig. 13.

TABLE 8.—TOTAL PERCENTAGE LOSS IN WEIGHT OF VALENCIA ORANGES IN STORAGE. (AVERAGE OF ALL FRUIT AT FOUR TEMPERATURES, 32°, 37½°, 42° AND 48°F.)

Wrapper	Storage Periods					
	1 Month	6 Weeks	2 Months	3 Months	4 Months	5 Months
Plain aluminum 45	0.3	0.5	0.8	1.2	1.9	2.2
M. T. cellophane	0.4	0.7	1.2	1.9	3.2	3.9
Waxed	2.9	4.4	6.9	9.5	....	....
Oiled	3.6	5.5	8.5	11.5	....	....
Tissue	3.6	5.5	8.4	11.5	....	....
Whalehide	4.0	6.0	9.3	12.4	....	....
None	3.8	5.9	9.2	12.9	....	....
Parchment	4.2	6.4	9.9	13.2	....	....
Average	2.8	4.4	6.8	9.3	2.6	3.0

Storage Pitting.—Practically no pitting occurred on the Valencia oranges.

General Appearance.—The figures of Table 9 show the superiority of the aluminum foil and moistureproof cellophane wraps

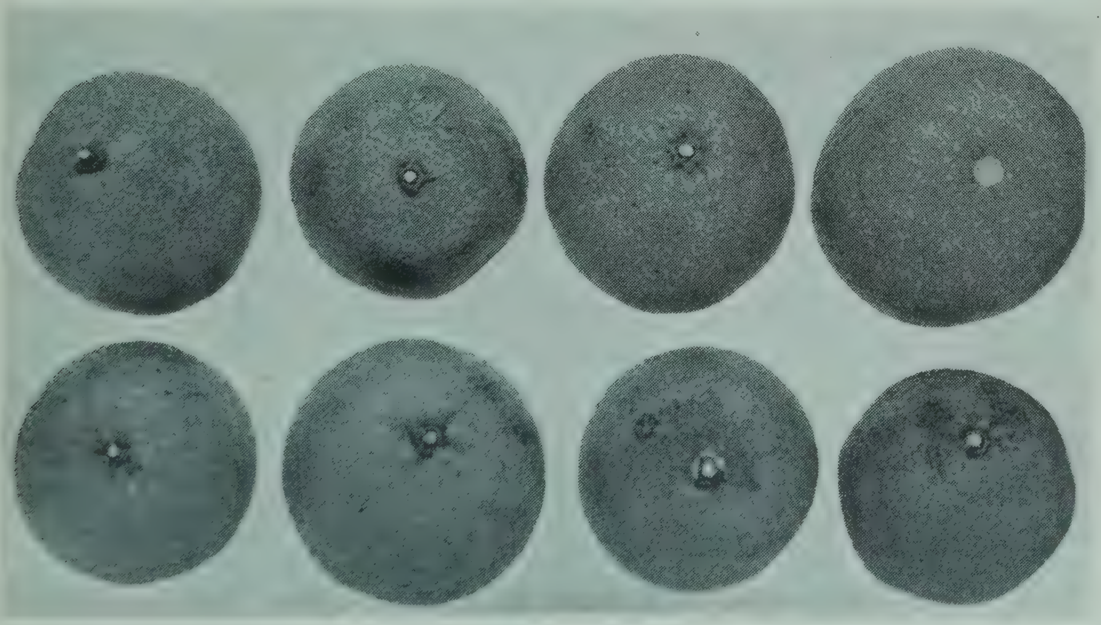

Fig. 14.—Typical Valencia oranges after four months' storage at 42°F. wrapped in the following: Top row (left to right), parchment, whalehide, M. T. cellophane, waxed. Bottom row (left to right), aluminum 65, oiled paper, tissue and none.

TABLE 9.—RELATIVE EFFECT OF VARIOUS WRAPPERS ON GENERAL APPEARANCE OF VALENCIA ORANGES. (AVERAGE OF FRUIT AT FOUR TEMPERATURES, 32°, 37½°, 42° AND 48°F.)

Wrapper	One Month's Storage Days After Removal				Six Weeks' Storage Days After Removal				Two Months' Storage Days After Removal				Three Months' Storage Days After Removal				Avg. for the Four Storage Periods—Days After Removal			Absolute Average
	1	3	5	Avg.	1	3	5	Avg.	1	3	5	Avg.	1	3	5	Avg.	1	3	5	All Examinations
Plain aluminum 45	100	100	100	100	100	100	100	100	100	100	89	96	98	100	87	95	100	100	98	99
M. T. cellophane	100	100	100	100	100	92	100	97	72	100	100	91	92	100	95	96	92	100	98	97
Waxed	88	95	78	87	90	90	62	77	90	72	35	66	57	61	41	53	79	74	54	69
Whalehide	90	88	74	84	85	53	26	55	57	54	35	49	43	37	14	31	71	60	40	57
Tissue	98	84	77	86	69	60	40	56	68	57	49	58	6	6	6	6	57	48	46	50
Oiled	93	84	57	78	66	49	67	61	62	37	23	41	6	29	17	17	57	46	43	49
None	93	85	55	78	88	52	43	61	47	43	17	36	6	6	6	6	57	46	32	45
Average	95	91	77	88	85	69	62	72	71	66	50	62	44	48	38	43	73	68	59	...

Score value:

Good	....	100
Fair	....	70
Bad	....	0

in preserving good appearance, the fruit remaining in good condition for three months. Waxed paper kept the fruit in a little better condition than the other paper wraps, all of which ranked about the same and had a slight advantage over no wraps (Fig. 14).

Depreciation of fruit after removal from storage was consistently greater in paper wraps than in M. T. cellophane and aluminum wraps. Fruit in the latter two showed no material falling off in quality during the five days out of storage.

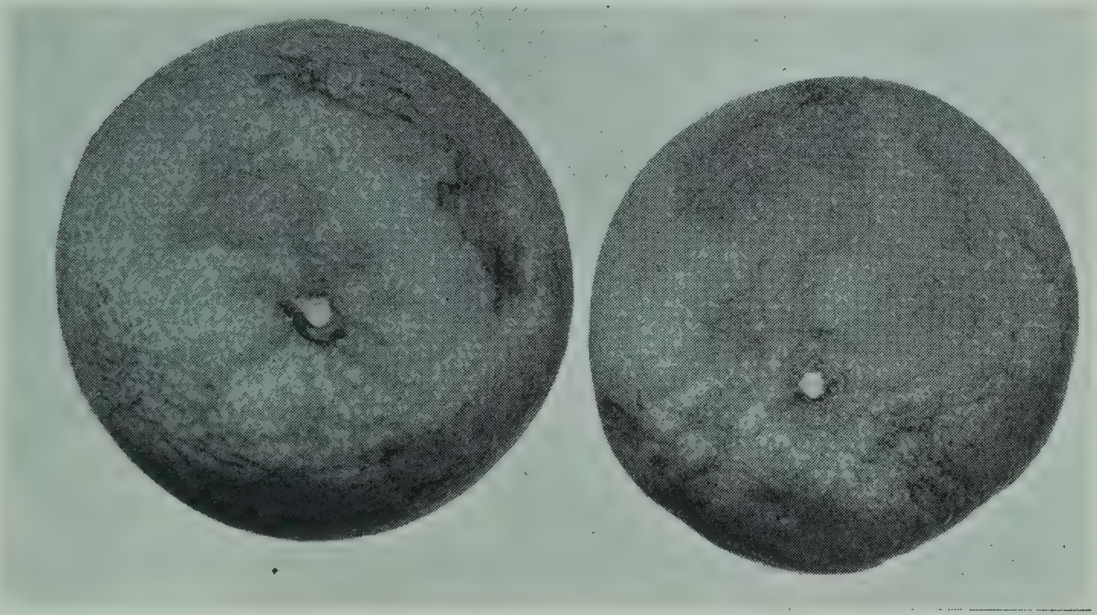

Fig. 15.—Typical stem-end drying of Valencia oranges.

There was very little difference shown in effect of temperature on general appearance. The fact that the Valencias did not pit, however, permitted fruit of this variety to be kept at lower temperatures, and therefore for a longer period, without seriously affecting the general appearance. (Figs. 14 and 15.)

Decay.—Much less decay developed in the Valencia than in the Pineapple oranges over the same period. More decay developed at the higher temperatures than at the lower, and the amount gradually increased as the storage periods became longer. There was not enough decay to afford a significant comparison among the wrappers.

COMMERCIALLY PACKED FRUIT

In addition to the above shelf experiments, Valencia oranges were wrapped with eight test wrappers and packed snugly without bruising in boxes using the commercial sizes and packs. Two boxes of fruit wrapped in each of the following wrappers were stored at 42° F. for four months without disturbing: waxed, oiled tissue, whalehide, parchment, plain aluminum and M. T. cellophane.

The results substantiated those obtained with the shelf experiments with the same wrappers. The moistureproof wrappers (M. T. cellophane and plain aluminum 45) showed the same relative efficiency in preserving general appearance and quality that they did in the shelf experiments. There was about the same amount of decay found in the fruit wrapped in the M. T. cellophane and aluminum foil as in the paper wraps. The unwrapped fruit showed slightly less decay than that in the wrappers but was poorer in general appearance and quality. Waxed paper showed very little increased efficiency over the other paper wraps. Considerable loss in weight (shrinkage) occurred in all boxes except those containing the fruit wrapped in moistureproof cellophane and aluminum foil. "Nesting" occurred in all boxes except those containing collophane and aluminum foil wrapped fruit, but was worse in those containing unwrapped fruit. Sweating of the fruit was noticed in all boxes after removal from storage, except those packed in aluminum foil. Less weight was lost per fruit when stored in boxes than when stored on shelves and exposed to the circulation of air. The percent of decay was about the same in the fruits in boxes as that on the shelves. Representative fruits from each wrapper are illustrated in Fig. 13.

MISCELLANEOUS OBSERVATIONS

Color.—Wrappers affected the color of the fruit only indirectly. As a fruit became dried in appearance it usually developed a duller shade.

Temperature had more effect than the wrapper. At high temperatures the stored fruit became noticeably deeper in color. This held true regardless of loss in weight, because turgid fruit at 48° F. had a distinctly deeper orange color than dried fruit at 37½° F. There was a noticeable difference in color, especially of Pineapple oranges, between fruit at 37½° and 42°, with the difference becoming even more marked between 42° and 48° F. The deeper orange color was not considered detrimental.

Taste.—All fruits at each examination were cut in halves and systematically tasted. None of the wrappers showed a detrimental effect on taste of the fruit. As fruit became dried and old, it developed a taste characteristic of over-ripe fruit.

The only effect of temperature seemed to be found on fruit stored at 32° F. At this temperature in both Pineapples and Valencias the fruit developed an "off" taste after several months' storage even when the fruit appeared perfectly good externally. This "off" taste became more obvious as the storage period increased and especially in those fruits which had been removed from storage several days. Fruit having this "off" taste later developed soggy breakdown in most cases.

After three or four months' storage most of the fruit had begun to lose its "fresh" taste and flavor, but with the exception noted above, sound, firm fruit seldom developed an objectionable taste. Fruit held in storage for a considerable period of time tended to develop an "old" taste much sooner after removal than that held for shorter periods.

Sweating After Removal.—The paper wrappers became thoroughly soaked through in about an hour after the fruit was removed from storage. Moisture would condense within the moistureproof wrappers, very little in aluminum foils and much in the cellophane wrappers. Most of this condensed moisture appeared within the M. T. and S. S. T. cellophane wraps before removal from the refrigeration rooms. Directly as the S. S. T. cellophane* became moist or wet by this condensation it began to flake off and in time tear and become worthless. Most of the condensed moisture quickly dried out when left at room temperature but some of the paper wraps had become useless due to tearing when wet. The moistureproof cellophane, however, retained the condensed moisture inside the wrapper for several days after removal from the cold rooms.

SUPPLEMENTARY EXPERIMENTS

Chemically-Treated Paper Wraps Tested.—Unwashed Pineapple oranges were wrapped with the two types of chemically-treated paper (containing 1.4% copper in the form of copper sulfate), and packed in boxes using the commercial pack. Ten boxes of each, together with two boxes of tissue-wrapped fruit, were stored at 37½°, 42° and 48° F. for four months. At monthly intervals the boxes were examined and decayed fruit removed. Loss in weight of individual boxes was recorded as well as the keeping quality and percent decay.

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*This grade of cellophane was later replaced by an S. A. T. grade which has all of the characteristics of the S. S. T. grade but does not flake off and disintegrate when it becomes moist.

In some instances fruit in the heavier chemical paper showed less decay than in the other two wraps, but only at 42° F. was the difference appreciable. The only mold "nests" found were in the boxes stored at 48° F., where practically the same amount occurred in each box.

There was less loss in weight in the fruit in the heavier chemical wrapper but the difference was of little significance. The loss in weight of fruit in all three wrappers was least at 37½° and highest at 48° F. Both stem-end rot and Penicillium mold were found throughout the storage period in the fruit in all three wrappers, showing no efficiency of the chemically treated wrappers in reducing decay in either amount or kind.

Moistureproof Lining of Citrus Storage Crates.—As a result of all of the experiments on wrappers for citrus fruits during cold storage the superiority of moistureproof wrappers in main-

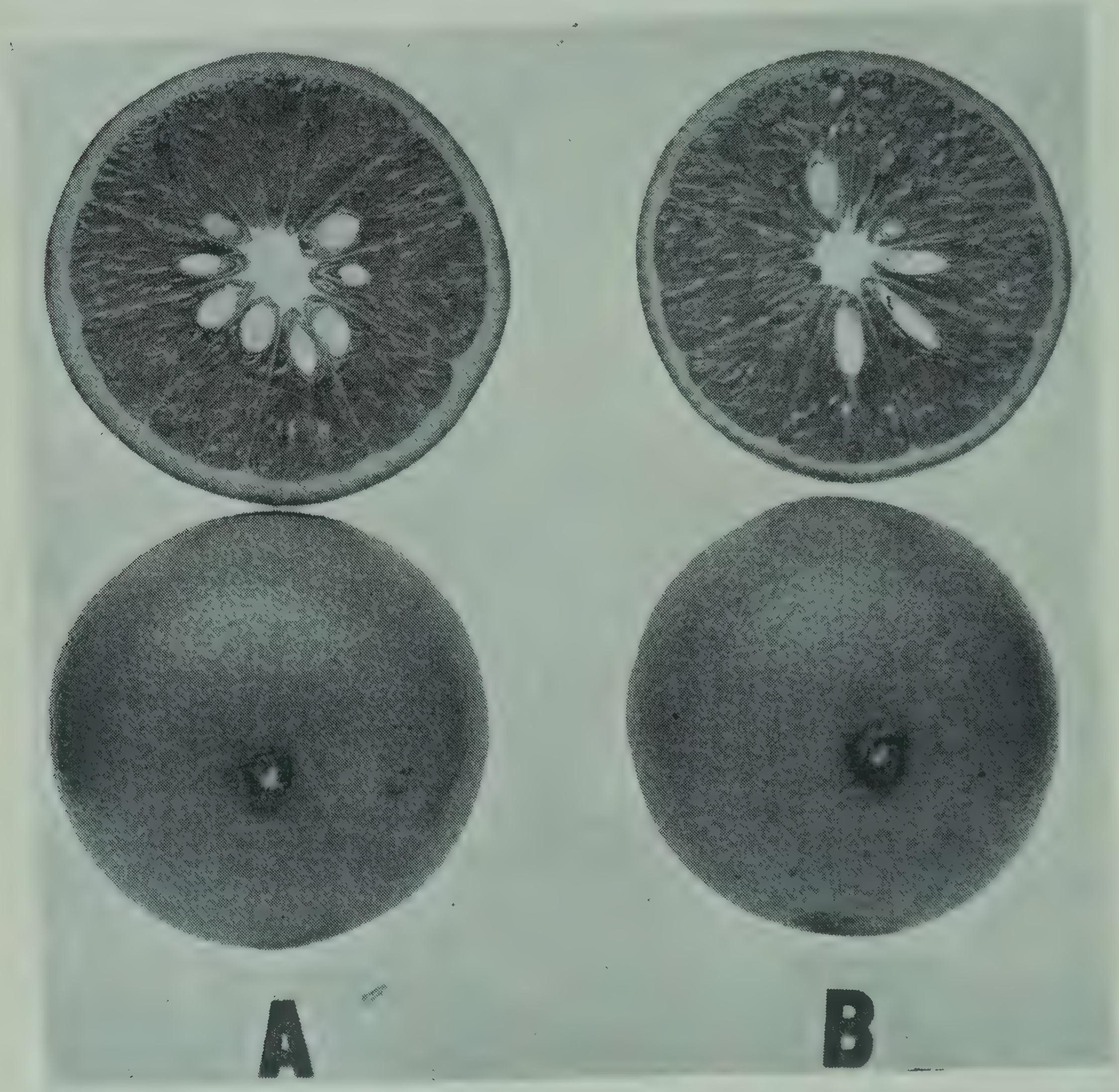

Fig. 16.—Pineapple oranges after three months' storage at 42°F. wrapped in (A) moistureproof cellophane and (B) moistureproof sylphrap.

TABLE 10.—EFFECT OF VARIOUS WRAPPERS AND CELLOPHANE-LINED CONTAINERS ON LOSS IN WEIGHT OF ORANGES STORED AT 37½° F.

Kind of Fruit	Box Lining	Fruit Wrapper	After 2 Wks.		After 4 Wks.		After 6 Wks.		After 8 Wks.		After 10 Wks.	
			Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss
Du Roi Oranges	None	None	0.75	1.92	1.50	3.85	1.50	3.85	2.50	6.46	3.25	8.51
Du Roi Oranges	None	Tissue	0.50	0.97	1.25	2.42	2.25	4.35	2.75	5.31	4.00	7.75
Du Roi Oranges	S. S. T. cellophane	None	0.38	0.59	0.63	0.96	1.00	1.52	1.25	1.90	1.88	2.88
Du Roi Oranges	S. S. T. cellophane	Tissue	0.25	0.41	0.50	0.82	0.75	1.22	1.25	2.04	1.50	2.45
Pineapple Oranges	None	None	0.75	1.26	1.50	2.51	2.25	3.77	3.25	5.44	4.00	6.80
Pineapple Oranges	None	Tissue	1.00	1.59	1.50	2.38	2.25	3.41	3.00	4.63	4.00	6.30
Pineapple Oranges	M. T. cellophane	None	0.00	0.00	0.00	0.00	0.38	0.60	0.75	1.19	1.13	1.85
Pineapple Oranges	M. T. cellophane	Tissue	0.00	0.00	0.38	0.64	0.75	1.19	1.00	1.60	1.50	2.45

Kind of Fruit	Box Lining	Fruit Wrapper	After 12 Wks.		After 14 Wks.		After 16 Wks.		After 18 Wks.		After 20 Wks.	
			Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss
Du Roi Oranges	None	None	3.50	9.20	4.00	10.83	4.25	11.64	5.00	13.29	5.25	14.31
Du Roi Oranges	None	Tissue	4.25	8.24	4.50	8.76	5.50	10.86	5.75	11.43	6.25	12.57
Du Roi Oranges	S. S. T. cellophane	None	2.51	3.84	3.00	4.78	3.13	5.02	3.63	6.00	4.13	7.18
Du Roi Oranges	S. S. T. cellophane	Tissue	1.75	2.86	2.25	3.74	2.50	4.18	3.00	5.09	3.25	5.56
Pineapple Oranges	None	None	5.00	8.62	5.75	10.88	5.75	10.88	7.00	15.55	7.25	16.76
Pineapple Oranges	None	Tissue	4.50	7.14	4.75	7.73	5.50	9.51	5.75	10.29	6.50	12.63
Pineapple Oranges	M. T. cellophane	None	1.38	2.28	1.88	4.11	2.00	4.55	2.00	4.55	2.13	5.41
Pineapple Oranges	M. T. cellophane	Tissue	1.50	2.45	1.75	3.06	2.00	3.66	2.25	4.62	2.50	5.65

taining weight and preserving the general appearance of the fruit has been established.

The expense of such wrappers has been a barrier to their commercial use and studies have been made with a view to reducing this cost and still retaining the benefits to be derived. Large bags which would fit the half of a commercial orange box and allow sufficient top for sealing and folding over were made from the various suitable moistureproof materials and used as box liners (Fig. 16). In a box packing 150 fruit one-fifteenth as much wrapping material is used in lining the box as when individual wrappers are used.

The effect of various wrappers and cellophane lined containers on the loss in weight of Du Roi and Pineapple oranges stored at 37½° F. over a five months' storage period is given in Table 10. The loss in weight in pounds and percent for every two weeks is given.

When comparing the box liners with the individual wraps, in regard to loss in weight, it is readily seen (Table 10) that the cellophane box liners with no wraps are much more efficient in moisture-retentiveness than the individual tissue wraps. Referring back to Table 1, it is seen that fruit individually wrapped in M. T. cellophane lost 0.8, 1.6, 2.5 and 3.4 percent of their weight after one, two, three and four months' storage at 37½° F., respectively. In Table 10 these corresponding figures for fruit stored with box liners of M. T. cellophane show 0, 1.19, 2.28 and 4.55 percent loss of weight for one, two, three and four months, respectively. It is shown here that the box liner is slightly better up to three months, which is a normal storage period, than individual wraps of the same material. Similar results are shown with other wrapping and lining materials. A combination of ordinary tissue wraps and semi-moistureproof liners proved to be very satisfactory but was not so efficient as the moistureproof liner used with tissue, or alone (Fig. 16).

Table 11 is a tabulation of the effect of various wrappers and box liners on the keeping quality of Du Roi and Pineapple oranges. The percent decay and percent good fruit are given after each month's storage at 37½° F. The oranges kept splendidly in the M. T. and the S. S. T. cellophane box linings. It will be noted from the table that fruit in the box liner bags kept much better than that packed with no box liner. Decay was greater in fruit wrapped individually in S. S. T. cellophane (Table 6) than when they were packed with plain tissue or with-

TABLE 11.—EFFECT OF VARIOUS WRAPPERS AND CELLOPHANE-LINED CONTAINERS ON THE KEEPING QUALITY OF VARIOUS CITRUS FRUITS STORED AT 37½° F.

Kind of Fruit	Box Lining	Fruit Wrapper	After 1 Mth.		After 2 Mths.		After 3 Mths.		After 4 Mths.		After 5 Mths.	
			% Good Fruit	% Decay	% Good Fruit	% Decay	% Good Fruit	% Decay	% Good Fruit	% Decay	% Good Fruit	% Decay
Du Roi Oranges	None	None	99.09	0.91	99.09	8.18	72.73	27.27	54.55	45.45	45.45	54.55
Du Roi Oranges	None	Tissue	100.00	0.00	99.14	0.86	91.38	8.62	84.48	15.52	81.03	18.97
Du Roi Oranges	S. S. T. cellophane	None	100.00	0.00	97.48	2.52	77.92	22.08	62.15	37.85	54.89	45.11
Du Roi Oranges	S. S. T. cellophane	Tissue	100.00	0.00	98.52	1.48	91.11	8.89	85.93	14.07	81.48	18.52
Pineapple Oranges	None	None	100.00	0.00	91.33	8.67	46.00	54.00	22.67	77.33	13.33	86.67
Pineapple Oranges	None	Tissue	100.00	0.00	93.51	6.49	61.69	38.31	43.51	56.49	31.17	68.83
Pineapple Oranges	M. T. cellophane	None	98.99	1.01	90.27	9.73	40.27	59.73	8.72	91.28	....	....
Pineapple Oranges	M. T. cellophane	Tissue	98.63	1.37	89.38	10.62	62.33	37.67	39.04	60.96	24.32	75.68

out a wrapper and only a box liner of S. S. T. cellophane used (Table 11). It is also apparent from the figures of the table that decay is higher under the moisture-retentive liner or wrapper than it is under the semi-moisture-retentive liner or wrapper.

The figures of both Tables 10 and 11 show that the expense of such costly wrappers as have proved to be beneficial in the cold storage of oranges can be greatly reduced without decreasing the efficiency of the wrapper by using the same material as a box liner.

Oranges were also wrapped in groups of six and 12 in airtight packages of moistureproof and semi-moistureproof cellophane wrappers. The results were comparable to individually wrapped fruit. The package proved to be attractive and would be convenient for handling in the retail store. In storage they were either placed on shelves after packaging or placed in the regular orange crate, one package on top of the other.

Comparison of Additional Wrappers and Box Liners.—A number of new wrapping materials have been placed on the market since this investigation of citrus wrappers was first begun. Among these are several new cellophane products and similar transparent wraps such as sylphrap and kodapak which are also cellulose acetate products, but produced by different companies.

A number of these were tried out on a large number of oranges and grapefruit during the 1934-35 fruit season, both as individual wraps and as liners to the packing box. Twenty-five Pineapple oranges were wrapped in each of seven wrappers and placed on shelves at 42° F. and weighed individually each week to determine the loss in weight. The following wrappers were used: Plain aluminum 65, M. T. cellophane, S. A. T. cellophane, P. S. T. cellophane, moistureproof sylphrap, regular kodapak, plain tissue and no wrapper.

Ten boxes of Pineapple oranges and 15 boxes each of Magnum Bonum and Centennial oranges were wrapped in the above wraps and packed in regular orange boxes using the commercial packing designs, or were packed in boxes lined with the transparent moistureproof wrapping material and sealed (Fig. 15). Since a storage temperature of 37½° F. is better for storing oranges and would not permit the comparison of wrappers so readily as a higher temperature, the fruit was placed in storage at 42° F. to facilitate study of the effect of wrappers on loss in weight and amount of decay.

TABLE 12.—Percent Loss in Weight of Pineapple Oranges Stored at 42° F. in Various Wrappers on Shelves and in Crates.

Wrapper	% Loss After 2 Weeks		% Loss After 4 Weeks		% Loss After 6 Weeks		% Loss After 8 Weeks		% Loss After 10 Weeks		% Loss After 12 Weeks	
	on Shelves	in Crates	on Shelves	in Crates	on Shelves	in Crates	on Shelves	in Crates	on Shelves	in Crates	on Shelves	in Crates
Plain aluminum 65	0.25	0.29	0.34	0.53	.61	0.58	.93	1.44	1.38	1.68	1.42	1.97
M. T. cellophane	0.12	0.28	0.22	0.28	.69	0.50	1.14	1.22	1.73	1.83	1.90	2.60
M. P. sylphrap	0.36	0.27	0.80	0.36	1.78	1.04	2.87	2.27	3.64	2.50	4.13	3.50
S. A. T. cellophane	2.60	0.57	3.46	1.11	5.32	1.47	7.19	2.65	7.76	3.01	8.76	3.80
Regular kodapak	3.34	1.30	4.37	2.28	6.35	2.79	8.31	4.17	9.83	4.35	10.87	5.00
P. S. T. cellophane	3.98	1.11	5.15	1.88	7.38	2.65	9.44	4.37	11.21	4.91	12.45	5.83
Plain tissue	4.02	1.94	5.23	3.39	7.22	3.65	9.55	5.10	11.14	5.53	12.27	6.19
None	4.51	1.73	5.89	2.87	8.26	3.57	10.85	5.16	13.10	5.93	14.31	7.15

Table 12 is a tabulation of the percent loss in weight of the Pineapple oranges in the various wrappers placed on shelves and weighed individually every two weeks. This table also gives loss in weight after every two weeks of commercially packed Pineapple oranges stored at 42° F. Moistureproof wrappers were by far the most efficient in preventing loss in weight, the sylphrap being slightly less efficient in this respect than plain aluminum foil or moistureproof cellophane. (Fig. 17.) The S. A. T. cellophane and regular kodapak were next best with the P. S. T. cellophane just slightly better than the plain tissue and no wrap. Moistureproof kodapak was also used here but would not stand up under the wrapping and handling. The slightest pressure or pull would tear or shatter the wrap. The regular kodapak was somewhat similar and only with very careful handling was its use possible.

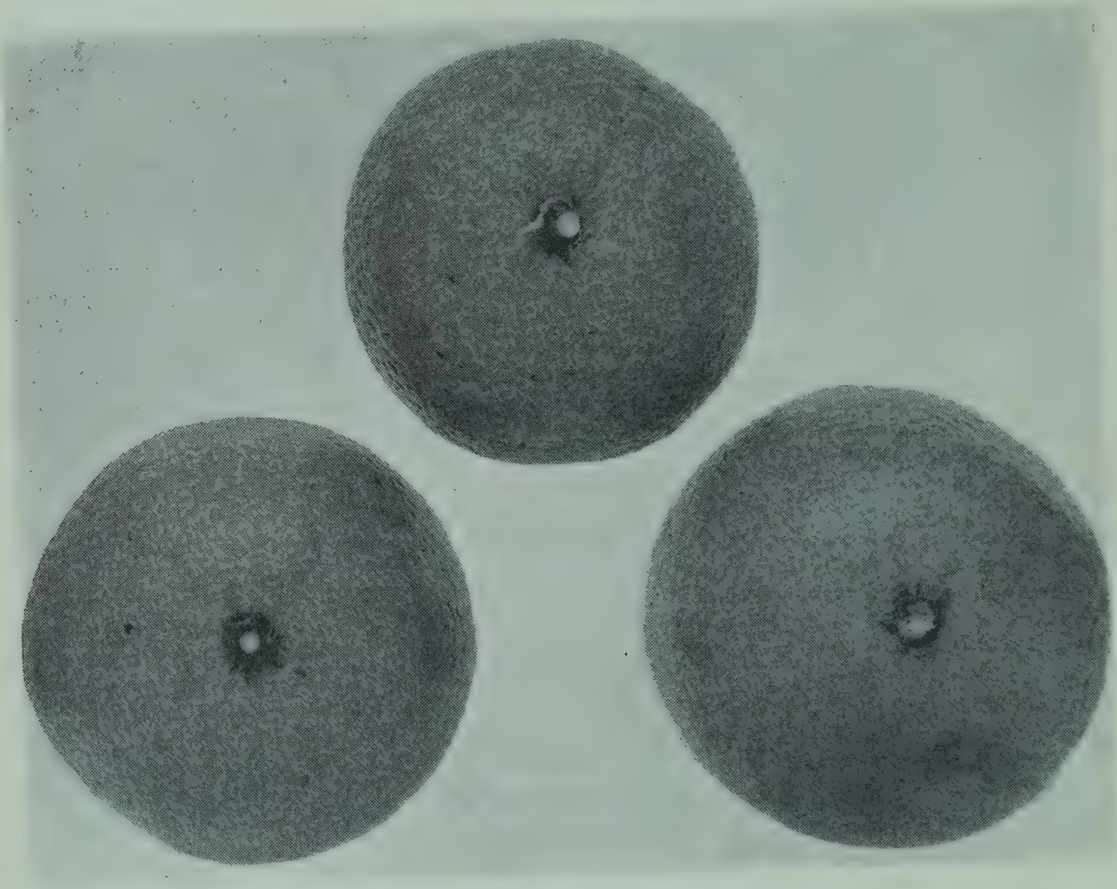

Fig. 17.—Typical Valencia oranges stored four months at 37½°F. wrapped in (left) moistureproof sylphrap, (middle) moistureproof kodapak, and (right) moistureproof cellophane.

With regard to loss in weight, the efficiency of the wraps was in the same order as when used in the commercially packed box as it was for the fruit weighed individually and placed on shelves. (Table 12.) The loss in weight of fruit packed in commercial crates was much less throughout the storage period than that stored on shelves with the exception of the moistureproof wrapped fruit in which the loss was very slight. Decay was much higher in the moistureproof wrappers than in the semi-moistureproof wrappers and others, the percent rots being highest in the moistureproof cellophane. The percent decay was lowest and almost negligible in the fruit wrapped in regular kodapak and next lowest in the S. A. T. cellophane. The wrappers are ranked in order of their efficiency as weight retainers in the table and would be ranked as to their efficiency to reduce the amount of decay as follows: Regular kodapak, S. A. T. cellophane, tissue, no wrap, P. S. T. cellophane, moistureproof sylphrap, plain aluminum 65, and M. T. cellophane.

Table 13 is a tabulation of the effect of the various wrappers on the pitting of Pineapple oranges stored at 42° F. The pitting examinations were made by recording the number of fruits in each wrapper showing 1, 2, 3, 4, etc. pits. To present the data in less complicated form, however, arbitrary score values were assigned as follows:

No pitting	100 points
One pit per fruit	94 points
Two pits per fruit	88 points
Three pits per fruit	82 points
Four pits per fruit	76 points
Five pits per fruit	70 points

The sum of the individual scores was divided by the number of fruits examined to obtain the average score of the sample.

TABLE 13.—EFFECT OF VARIOUS WRAPPERS ON THE PITTING* OF PINEAPPLE ORANGES STORED AT 42° F.

Wrapper	After 1 Month	After 2 Months	After 3 Months	After 4 Months	After 5 Months
Regular kodapak	98.5	98.1	98.0	98.0	98.0
S. A. T. cellophane	98.0	96.9	96.4	96.4	96.4
Tissue	96.4	96.4	96.3	96.1	96.1
P. S. T. cellophane	95.1	95.1	94.7	93.7	93.7
None	96.0	96.0	96.0	95.5	95.2
Plain aluminum 65	97.2	97.2	95.0	90.1	90.1
Moistureproof cellophane	97.5	96.1	90.8	90.2	89.8
Moistureproof sylphrap	94.3	81.8	77.0	62.8	76.0

*Score Values for Pits per fruit: 1=94, 2=88, 3=82, 4=76, 5=70.

TABLE 14.—EFFECT OF VARIOUS WRAPPERS AND MOISTUREPROOF BOX LININGS ON LOSS IN WEIGHT* OF CENTENNIAL ORANGES STORED AT 42° F. AFTER DIFFERENT LENGTHS OF STORAGE PERIOD.
(Expressed in kilograms and percent.)

Box Lining	Wrapper	2 wks.		4 wks.		6 wks.		8 wks.		10 wks.	
		kgs.	%	kgs.	%	kgs.	%	kgs.	%	kgs.	%
M. P. cellophane	Tissue	.00	.00	.01	.04	.04	.15	.10	.37	.15	.55
M. P. sylphrap	None	.05	.17	.05	.17	.07	.24	.20	.67	.26	.87
M. P. cellophane	None	.07	.25	.08	.29	.12	.43	.18	.65	.47	1.70
Plain sylphrap	None	.05	.24	.14	.67	.14	.67	.26	1.24	.26	1.24
Regular kodapak	None	.13	.46	.15	.53	.15	.53	.24	.85	.24	.85
Plain slyphrap	Tissue	.11	.48	.11	.48	.15	.65	.24	1.04	.28	1.21
No Lining (check)	Tissue	.37	1.61	.46	2.00	.63	2.74	.96	4.17	1.11	4.82
No Lining (check)	None	.43	1.98	.52	2.39	.76	3.49	1.16	5.33	1.29	5.93

Box Lining	Wrapper	12 wks.		14 wks.		16 wks.		18 wks.		20 wks.	
		kgs.	%	kgs.	%	kgs.	%	kgs.	%	kgs.	%
M. P. cellophane	Tissue	.18	.66	.31	1.13	.37	1.35	.37	1.35	.37	1.35
M. P. sylphrap	None	.40	1.34	.57	1.91	.75	2.51	.75	2.51	.79	2.64
M. P. cellophane	None	.55	1.99	.67	2.42	.70	2.53	....	....	....	....
Plain sylphrap	None	.31	1.48	.50	2.38	.57	2.71	.59	2.81	.65	3.11
Regular kodapak	None	.29	1.03	.59	2.09	.93	3.29	.98	3.47	.98	3.47
Plain sylphrap	Tissue	.49	2.13	.69	3.00	.76	3.31	.85	3.70	.86	3.74
No Lining (check)	Tissue	1.21	5.25	1.64	7.12	1.97	8.55	1.18	9.46	1.28	9.89
No Lining (check)	None	1.53	7.03	2.15	9.88	2.37	10.89	2.76	12.68	2.85	13.09

*The loss in weight due to rots was subtracted each time and the percentage was based on good fruit only.

Regular kodapak was most efficient in preventing or reducing the number of pits; S. A. T. cellophane next, with the tissue, P. S. T. cellophane and no wrap following with about the same values. The moistureproof wraps were the least efficient, the moistureproof cellophane and sylphrap being less efficient than the plain aluminum foil in this regard.

Considering loss in weight, amount of decay and severity of pitting, the moistureproof wrappers and the S. A. T. cellophane and regular kodapak were the best wraps in the order named; the pitting and decay being about negligible in the latter two, while the retention of quality in the fruit in the moistureproof wrappers outweighed the small loss by decay and pitting. Similar data were obtained for Magnum Bonum and Madame Vinous oranges and the effects of the various wrappers were exactly the same for these varieties as they were for Pineapple oranges.

The effect of various wrappers and moistureproof lined crates on the loss of weight of Centennial oranges stored at 42° F. over a 20 weeks' period is given in Table 14. The fruit was packed in commercial packs in regular citrus boxes. The boxes of fruit were weighed at two-week intervals to an accuracy of .01 kilogram.

When comparing the box liner with the single wrap it is readily seen that the box liner was as efficient as the single wrapper in preventing loss in weight. The moistureproof cellophane was slightly superior to the moistureproof sylphrap and the plain sylphrap slightly superior to the regular kodapak. Here again the combination of ordinary tissue wraps and the moistureproof liner proved to be very satisfactory. When tissue was not used, "nesting" occurred more readily and a higher percentage loss from decay was obtained.

The percent decay was highest in the moistureproof wrappers and liners than other wraps and lowest in the check boxes of no wraps or ordinary tissue, with the exception of regular kodapak, in which the decay was almost negligible.

The pitting examinations were made in a manner similar to those for the Pineapple oranges; the arbitrary score values assigned were the same for the Centennial oranges as those given above for the Pineapple oranges. The recording of the amounts of pitting was made difficult due to the fact that oftentimes pitted fruit would be discarded because of decay and then again fruit not pitted would decay. The average pitting was recorded for good fruit only. This should be taken into consideration

TABLE 15.—EFFECT OF VARIOUS WRAPPERS AND BOX LININGS ON THE PITTING* OF CENTENNIAL ORANGES.

Lining Wrapper	1 Month	2 Months	3 Months	4 Months	5 Months
None (check) Tissue	96.0	95.5	95.5	95.5	95.3
Regular kodapak None	96.1	95.5	95.0	95.0	94.2
None (check) None	95.8	94.9	92.9	91.9	91.9
Moistureproof sylphrap None	96.7	92.8	92.8	91.0	91.0
Moistureproof sylphrap Tissue	98.9	91.2	91.2	91.2	86.1
Moistureproof cellophane None	93.0	91.6	90.4	90.4	......
Moistureproof cellophane Tissue	89.9	89.0	89.0	89.0	89.0

*Score value for pits per orange: 0=100; 1=94; 2=88; 3=82; 4=76; 5=70.

when interpreting the results. The pitting score values for Centennial oranges are given in Table 15.

Pitting was highest in the Centennial oranges which were packed in the moistureproof lined boxes, but at no time was it severe enough to cause any of the fruit to be unmarketable. Pitting was least in the regular kodapak lined box and most extensive in the moistureproof cellophane lined box. There was very little difference in amount and severity of pitting between fruit packed in lined boxes and that individually wrapped.

The above values of Tables 14 and 15 show that the box liner is as efficient as the single wrap, with regard to loss in weight and nearly as efficient with regard to decay and storage pitting. The values show that the expense of such costly wrappers as have proved to be beneficial in citrus cold storage can be greatly reduced without decreasing their efficiency by using the same material as a box liner. The values also show that the new cellulose acetate moistureproof wraps, such as sylphrap and kodapak, are equal in most respects to moistureproof cellophane (Fig. 18) and that the S. A. T. cellophane proved a much better semi-moistureproof wrap than the S. S. T. cellophane. This new S. A. T. cellophane did not flake off or disintegrate when it became wet like the former S. S. T. grade. Both grades of kodapak tore easily and did not lend themselves to the handling and wrapping of oranges or grapefruit without tearing and shattering. Sylphrap, however, was found to stand up as well as cellophane in this regard.

Commercial Storage of Oranges.—This experiment was started on April 6, 1933, when 160 boxes of Valencia oranges were

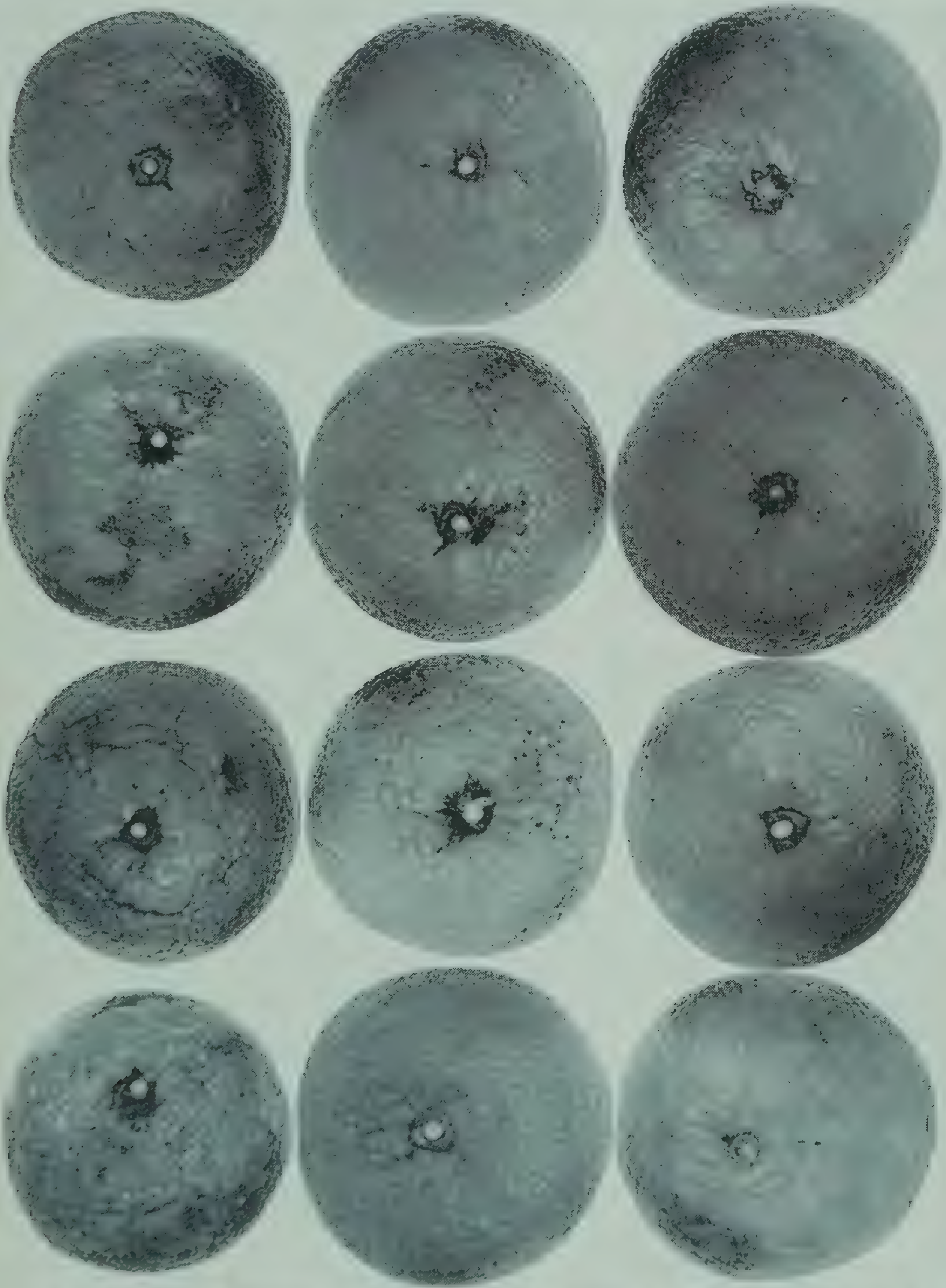

Fig. 18.—Valencia oranges after four months' storage at 37½°F. in the following wrappers, left to right: Top row, oiled paper, regular kodapak, and plain aluminum foil 65; second row, P. T. cellophane, S. A. T. cellophane, and moistureproof cellophane; third row, plain tissue, prosperity parchment, and moistureproof sylphrap; bottom row, no wrap, household waxed paper, and moistureproof kodapak.

wrapped and packed at the Mammoth Grove Packinghouse at Lake Wales and shipped by truck to Gainesville, where they were immediately placed in cold storage. They were divided equally and one-half wrapped with moistureproof cellophane and the other half with semi-moistureproof cellophane, with six boxes wrapped in plain tissue as a check and all placed at 37½° F. Twenty-five boxes each wrapped in S. S. T. cellophane were placed at temperatures of 42° F. and 32° F., with two boxes at each temperature wrapped in plain tissue as checks.

During the latter part of July, August and the early part of September this fruit was sold locally. Arrangements were made with the storekeepers to take the boxes directly from the storage rooms and return for credit all fruit which had decayed while in cold storage or during the first week after removal from storage. The acceptance by the storekeepers was slow at first due to former disastrous experiences with stored fruit. Later in the summer the demand exceeded the supply and no difficulty was experienced in disposing of the fruit in competition with California fruit that had not been stored. In fact, the preference was for the Florida fruit even when the price was higher for fruit of equal size. The Valencia oranges kept much better and for a longer time than the Marsh Seedless grapefruit which were placed in storage under the same conditions and at the same time. The grapefruitt kept in good condition for three months while the oranges remained in good condition for five months. Following is a tabulation of the percent good and decayed fruit as calculated from amount of decayed fruit returned by the storekeepers (Table 16).

Valencia oranges kept best at 37½° F. in the moistureproof and semi-moistureproof wrappers. Fruit at 32° F. kept much better during cold storage than that held at higher temperatures but did not stand up as well after removal from storage. The moistureproof wrap was slightly superior to the semi-moistureproof wrap in that less shriveling occurred in these wraps and the fruit had a better general appearance, while there was less decay and pitting in the semi-moistureproof wrappers. Eighty-seven percent of the Valencia oranges which were placed in storage in April were marketed four and five months later in preference to California fruit that had not been stored, at the same price or higher.

This experiment was repeated with 200 boxes of Valencia oranges the following year, using fruit from the Lake Alfred

Experiment Station, the sizing, packing and wrapping being done by hand. Similar results were obtained with practically the same percentage marketable fruit after three, four and five months' storage.

TABLE 16.—QUALITY AND MARKETABILITY OF VALENCIA ORANGES PLACED ON SUMMER MARKET AFTER COLD STORAGE.
(Placed in storage after April 6, 1933.)

Storage Temperature (°F.)	Wrapper	Length of Storage Period (Months)	% Decayed	% Marketed
32	S. S. T. cellophane	4	10	90
32	S. S. T. cellophane	5	17	83
32	Tissue	5	30	*
37½	S. S. T. cellophane	4	11	89
37½	S. S. T. cellophane	5	15	85
37½	Tissue	5	25	*
42	S. S. T. cellophane	4	11	89
42	S. S. T. cellophane	5	18	82
42	Tissue	5	38	*
37½	M. T. cellophane	4	10	90
37½	M. T. cellophane	5	12	88

*Fruit had lost too much weight and was too shriveled to be marketable.

In addition to the moistureproof cellophane, other transparent moistureproof wraps, such as sylphrap and kodapak, were used. The results were practically the same for the three wrappers; the cellophane proving to be slightly the best with regard to retention of weight, but equal in other respects. Here again the kodapak wrapper would not withstand the handling necessary for wrapping and would tear with the least amount of pressure or twisting. Figure 18 shows typical Valencia oranges after four months' storage at 37½° F. wrapped in moistureproof cellophane, sylphrap and kodapak.

In addition to the moistureproof wrappers in which the majority of the fruit was wrapped, 10 boxes each of fruit enclosed in the following wrappers were placed at 37½° F.: plain aluminum foil 65, regular kodapak, S. A. T. cellophane, prosperity parchment, household waxed, oiled, P. T. cellophane, plain tissue

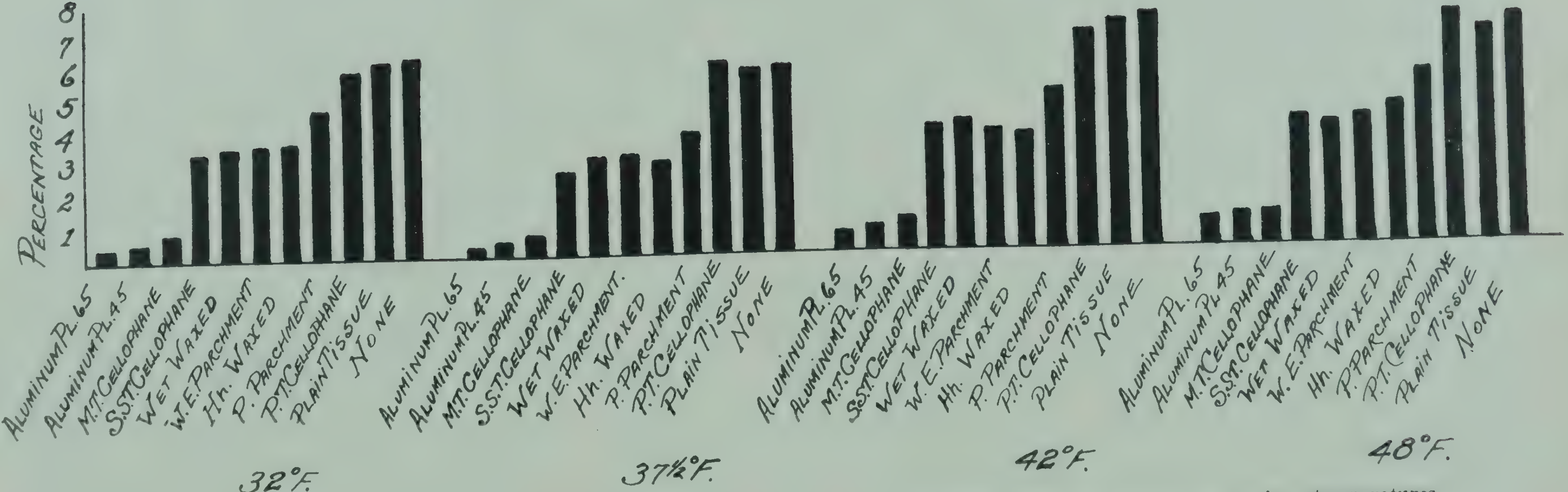

Fig. 19.—Relative effect of wrappers on loss in weight of Silver Cluster grapefruit stored two months at various temperatures.

and no wrap. Considering the general appearance, amount of pitting and decay, loss in weight and taste, the efficiency of the wrappers was found to rank as follows: plain aluminum foil 45, M. T. cellophane, moistureproof sylphrap, moistureproof kodapak, regular kodapak, S. A. T. cellophane, prosperity parchment, household waxed, oiled, P. T. cellophane, plain tissue and no wrap. Figure 19 shows typical Valencia oranges after four months' storage at 37½° F. wrapped in the above wrappers.

The bulge pack was compared to the straight pack. Ten percent more fruit was marketable after four months from the straight than from the bulge-packed boxes. The percent decay was higher in the bulge than in the straight pack. (Figs. 5 and 21.)

The fruit was repacked before being placed in the storekeepers' hands, and all decayed and bad fruits were removed. The fruit sold fast enough so that very little decayed on the retail stands and the storekeepers were willing to stand this loss when only good, sound fruit was delivered. Again, like the results of the year before, the Florida stored oranges were greatly preferred to California oranges when same sizes were sold at the same price during the summer months of 1934.

EXPERIMENTS WITH GRAPEFRUIT

All of the fruit used in this investigation was of the Silver Cluster variety of grapefruit (*Citrus paradisi*). They were picked at the Lake Alfred Experiment Station and washed and graded in a packinghouse at Lowell, Florida, and wrapped at Gainesville. They were placed in storage less than eight hours after picking.

Immediately upon arriving at Gainesville the fruit was wrapped in various wrappers and placed at each of seven different temperatures: 32°, 37½°, 42°, 48°, 54°, 58° F., and room temperature. Wrappers used were two aluminum foils, gauge .00045″ and .00065″; three grades of cellophane, M. T. (moistureproof), S. A. T. (semi-moistureproof), and P. T. (nonmoistureproof); two parchment papers, prosperity and white eagle brands; two waxed papers, wet waxed and household waxed; plain tissue paper and no wrap.

In addition to the 2,000 fruits on which the loss in weight was determined 20 fruits were wrapped in each of 10 wrappers and these, plus 20 fruits not wrapped, were placed at each of seven temperatures to be used for pitting and decay records. A total of 3,500 fruits were used in the experiment.

In order to have all of the sets as nearly alike as possible to insure against error, approximately one-third of each set was large, one-third small and the other third medium sized fruit.

The loss in weight, percent decay and storage pitting, taste and general condition and appearance, and percent marketable fruit were determined at regular intervals throughout the storage period or during the time they remained marketable.

Loss in Weight.—Table 17 gives the loss in weight in grams and percentage loss in weight of the fruit in the different wrappers at each temperature. All figures in Table 17 are averages of 25 fruit. The table has been so arranged that the wrappers are ranked according to their efficiency for reducing loss in weight. The figures of the table bring out the marked superiority of the aluminum foil and moistureproof cellophane wraps over the other wraps. The grades of semi-moistureproof cellophane are slightly superior to the plain tissue wrap in this regard and at the warmer temperatures are not so efficient as the wet waxed and paper parchment wrappers. The wet waxed papers were superior to the parchment papers and the P. T. or thin grade of cellophane. The P. T. cellophane, the thinnest grade of cellophane used, was less efficient as a weight retainer than the plain tissue wrap at most of the storage temperatures, and at several temperatures the fruit wrapped in P. T. cellophane lost more weight than did those with no wrapper. (Fig. 20.) This can probably be explained by the fact that the skin of the unwrapped fruit dried out quickly, thus permitting less moisture

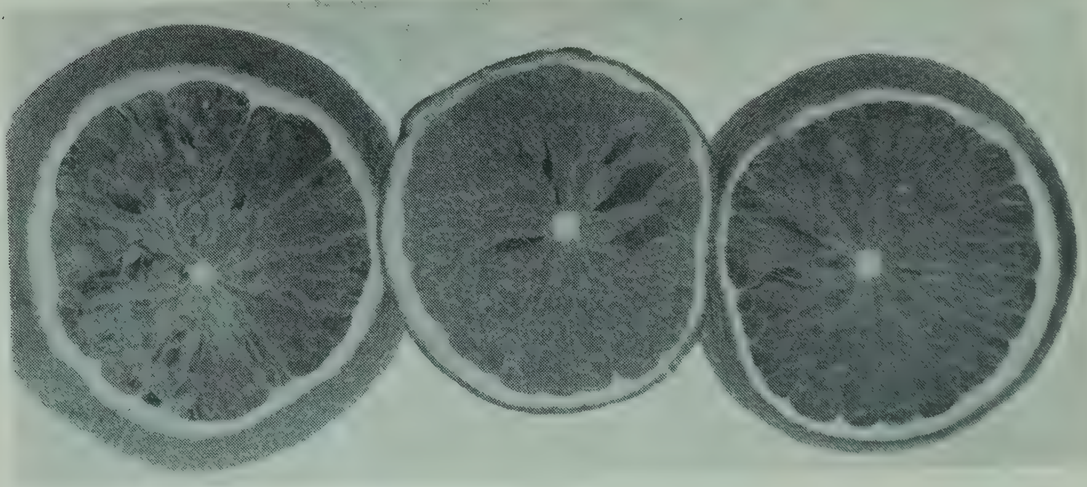

Fig. 20.—Internal breakdown resulting from bulge-pack bruising in Valencia oranges stored four months at 42°F.

TABLE 17.—LOSS IN WEIGHT OF SILVER CLUSTER GRAPEFRUIT STORED AT VARIOUS TEMPERATURES IN VARIOUS WRAPPERS.*

Temp.	Wrapper	After 1 Month		After 2 Months		After 3 Months		After 4 Months		After 5 Months	
		gms.	percent	gms.	percent	gms.	percent	gms.	percent	gms.	percent
32 F.	Aluminum foil (.00065")	1.1	0.22	1.6	0.32	2.7	0.54	4.0	0.81	5.3	1.35
	Aluminum foil (.00045")	1.3	0.27	2.3	0.48	3.6	0.75	5.5	1.14	6.8	1.47
	M. T. cellophane	2.1	0.42	3.6	0.72	5.5	1.11	8.6	1.72	11.0	2.29
	S. S. T. cellophane	9.4	1.95	15.7	3.26	22.2	4.62	29.5	6.23	37.5	8.11
	Wet waxed paper	9.1	1.86	16.3	3.33	23.4	4.79	31.9	6.47	40.8	8.23
	White eagle parchment	9.9	1.95	17.3	3.41	24.9	4.91	32.9	6.48	43.0	8.38
	Household waxed paper	8.9	1.81	16.8	3.42	24.5	4.99	32.8	6.68	42.3	8.55
	Prosperity parchment	13.3	2.63	22.3	4.41	31.3	6.20	40.7	8.06	51.2	10.13
	P. T. cellophane	16.9	3.41	29.0	5.85	40.4	8.15	51.7	10.43	64.8	12.96
	Plain tissue	17.1	3.66	28.5	6.10	39.4	8.43	50.8	10.87	63.5	13.59
	None	17.3	3.63	29.2	6.12	40.4	8.47	51.9	10.88	65.3	14.14
	Average	9.7	1.98	16.6	3.40	23.5	4.81	30.9	6.34	39.2	8.11
37½° F.	Aluminum foil (.00065")	0.9	0.18	1.3	0.27	2.9	0.59	4.3	0.88	5.5	1.14
	Aluminum foil (.00045")	0.8	0.17	1.6	0.33	4.0	0.83	5.5	1.15	7.9	1.63
	M. T. cellophane	0.9	0.18	2.5	0.50	6.1	1.22	8.7	1.72	11.6	2.30
	S. S. T. cellophane	4.9	0.97	11.6	2.30	20.0	3.96	28.5	5.58	36.2	7.07
	Wet waxed paper	3.4	0.77	12.9	2.94	21.7	4.94	30.7	7.03	39.2	8.89
	Household waxed paper	6.4	1.28	13.9	2.75	25.2	4.99	35.5	7.03	44.7	8.85
	White eagle parchment	6.6	1.32	14.8	2.95	24.4	4.86	34.1	6.75	43.6	8.53
	Prosperity parchment	7.8	1.63	17.4	3.63	28.7	5.98	40.1	8.36	49.7	10.47
	Plain tissue	13.0	2.66	27.3	5.59	42.5	8.84	57.6	12.22	70.5	14.96
	None	12.4	2.47	28.5	5.68	44.6	8.88	61.1	12.37	76.1	15.39
	P. T. cellophane	13.7	2.94	27.5	5.89	44.2	9.47	59.5	12.46	72.3	15.35
	Average	6.4	1.32	14.5	2.98	24.0	4.96	33.2	6.87	41.6	8.60

TABLE 17.—LOSS IN WEIGHT OF SILVER CLUSTER GRAPEFRUIT STORED AT VARIOUS TEMPERATURES IN VARIOUS WRAPPERS.* *Continued.*

Temp.	Wrapper	After 1 Month		After 2 Months		After 3 Months		After 4 Months		After 5 Months	
		gms.	percent	gms.	percent	gms.	percent	gms.	percent	gms.	percent
42°F.	Aluminum foil (.00065″)	1.7	0.34	2.9	0.58	4.0	0.80	5.2	1.05	6.8	1.43
	Aluminum foil (.00045″)	2.0	0.40	3.4	0.67	5.5	1.09	7.3	1.45	9.9	2.00
	M. T. cellophane	3.7	0.73	5.2	1.03	8.4	1.66	12.5	2.55	16.0	3.36
	Household waxed paper	8.7	1.74	16.8	3.36	24.4	4.87	34.1	6.81	44.0	8.61
	S. S. T. cellophane	10.3	2.09	17.5	3.51	24.0	4.82	32.5	6.48	40.7	8.27
	White eagle parchment	10.2	1.94	18.4	3.51	25.6	4.88	35.0	6.69	44.9	8.61
	Wet waxed paper	10.1	2.17	17.3	3.71	24.1	5.17	32.7	7.10	42.3	8.80
	Prosperity parchment	14.0	2.86	23.8	4.69	32.6	6.65	44.2	8.68	55.9	10.62
	P. T. cellophane	19.4	3.96	32.1	6.56	43.3	8.85	57.6	11.31	71.6	14.31
	Plain tissue	18.7	4.03	32.5	7.00	43.5	9.36	56.8	12.06	71.5	15.06
	None	20.4	4.20	34.6	7.12	46.7	9.60	62.3	11.97	78.8	13.85
	Average	10.8	2.22	18.6	3.79	25.6	5.25	34.6	6.92	43.9	8.63
48°F.	Aluminum foil (.00065″)	1.9	0.38	3.5	0.73	4.9	1.05	6.0	1.34	7.5	1.70
	Aluminum foil (.00045″)	2.4	0.48	4.0	0.80	6.2	1.28	7.6	1.53	9.8	2.01
	M. T. cellophane	1.9	0.39	4.0	0.85	7.9	1.66	10.5	2.23	13.7	3.15
	Wet waxed paper	9.5	1.99	17.1	3.55	26.4	5.49	34.6	6.65	46.1	8.88
	S. S. T. cellophane	10.3	2.18	17.4	3.67	26.2	5.31	31.2	6.56	41.8	8.79
	White eagle parchment	11.0	2.17	19.6	3.75	29.1	5.52	37.5	6.69	49.5	8.69
	Household waxed paper	11.0	2.23	19.8	4.08	28.3	5.63	35.2	6.64	46.4	8.71
	Prosperity parchment	13.6	2.91	24.0	5.11	35.1	7.16	45.0	8.96	58.4	11.24
	Plain tissue	17.6	3.64	30.6	6.31	44.4	9.31	55.8	10.90	72.9	15.02
	None	19.8	4.01	33.2	6.86	47.2	9.13	58.3	10.83	75.7	15.07
	P. T. cellophane	20.2	4.30	33.3	7.00	47.5	9.89	58.1	12.25	74.5	15.71
	Average	10.8	2.24	18.8	3.88	27.6	5.58	34.5	6.78	45.1	9.00
54°F.	Aluminum foil (.00065″)	2.9	0.58	4.5	0.88	6.4	1.24	8.1	1.48	11.0	2.07
	Aluminum foil (.00045″)	4.0	0.80	5.6	1.12	8.1	1.62	10.4	2.06	14.3	2.86
	M. T. cellophane	4.1	0.83	6.9	1.39	10.3	1.98	14.4	2.78	21.0	4.04
	Household waxed paper	20.7	4.06	31.2	6.01	45.8	8.59	58.3	10.78	77.8	13.68
	Wet waxed paper	20.0	4.32	31.7	6.58	45.3	9.15	57.5	11.15	78.2	18.06
	White eagle parchment	21.5	4.46	33.6	6.73	47.0	8.94	58.3	11.39	75.3	14.71
	S. S. T. cellophane	21.0	4.31	33.1	7.15	46.3	9.23	59.3	11.17	79.5	14.98
	Prosperity parchment	27.9	5.68	42.7	8.64	61.3	12.11	76.1	15.03	97.9	18.65
	Plain tissue	31.4	6.39	49.9	9.05	69.6	12.09	86.0	13.99	111.9	17.80
	P. T. cellophane	36.0	7.13	54.4	10.73	75.9	14.42	93.7	17.84	121.0	23.04
	None	40.2	8.05	59.8	11.67	85.4	16.16	105.9	19.56	138.4	25.57
	Average	20.9	4.24	32.1	6.36	45.6	8.68	57.1	10.66	75.1	14.13

TABLE 17.—LOSS IN WEIGHT OF SILVER CLUSTER GRAPEFRUIT STORED AT VARIOUS TEMPERATURES IN VARIOUS WRAPPERS.*
Continued.

Temp.	Wrapper	After 1 Month		After 2 Months		After 3 Months		After 4 Months		After 5 Months	
		gms.	percent	gms.	percent	gms.	percent	gms.	percent	gms.	percent
58°F.	Aluminum foil (.00065")	2.6	0.52	5.6	1.09	7.8	1.52	10.9	2.14	......	......
	Aluminum foil (.00045")	4.8	0.97	8.8	1.81	12.6	2.67	17.2	3.60	......	......
	M. T. cellophane	5.6	1.14	11.0	2.13	19.0	3.81	26.6	5.40	......	......
	Wet waxed paper	18.8	3.95	33.7	6.99	53.9	11.53	75.5	16.15	......	......
	S. S. T. cellophane	21.5	4.41	39.0	7.35	61.6	11.86	86.3	16.62	......	......
	Household waxed paper	21.5	4.23	38.9	7.73	59.3	12.26	81.6	16.59	......	......
	White eagle parchment	23.6	4.83	42.4	8.14	68.1	12.92	94.6	18.08	......	......
	Prosperity parchment	29.1	5.75	51.2	9.93	82.2	15.49	117.3	20.24	......	......
	Plain tissue	33.9	6.84	60.5	11.30	92.6	17.43	127.1	23.75	......	......
	P. T. cellophane	38.2	7.60	66.9	12.68	106.8	19.70	146.8	27.05	......	......
	None	35.4	8.07	64.1	13.04	94.0	20.58	123.7	27.08	......	......
	Average	21.4	4.39	38.4	7.47	59.8	11.80	82.5	16.06	......	......
Room Temp. (70-80°F.)	Aluminum foil (.00065")	1.9	0.37	5.3	1.03	8.0	1.53	11.8	2.23	16.7	3.19
	Aluminum foil (.00045")	3.7	0.72	9.3	1.92	13.2	2.73	18.9	3.91	26.5	5.48
	M. T. cellophane	6.1	1.18	11.8	2.23	20.4	4.06	31.2	6.45	45.6	9.42
	Household waxed paper	19.6	3.92	40.8	7.83	61.9	12.17	82.2	16.16	103.8	20.40
	Wet waxed paper	18.8	3.75	38.4	8.13	58.1	12.27	77.6	15.78	99.2	19.49
	White eagle parchment	21.9	4.28	42.8	8.53	65.2	13.16	86.9	18.32	112.1	23.63
	Plain tissue	28.7	5.77	50.5	8.23	72.2	11.53	92.5	18.19	114.7	22.55
	S. S. T. cellophane	20.9	4.29	43.6	8.48	71.3	13.97	96.2	18.85	130.9	25.85
	Prosperity parchment	26.8	5.45	48.6	8.96	73.8	14.56	95.9	19.68	120.9	22.39
	None	30.9	5.63	51.7	9.63	73.6	13.99	96.8	18.40	124.2	23.60
	P. T. cellophane	37.9	7.09	72.0	13.70	104.8	19.89	140.9	26.72	179.0	32.70
	Average	19.7	3.86	37.7	7.15	56.6	10.90	75.5	14.97	97.7	18.97

*Each figure is average of 25 fruits.

loss from the pulp than from those wrapped in the P. T. cellophane. The cellophane wrapper did not permit the skin to dry and harden to the extent of the unwrapped fruit, but kept it in a somewhat normal condition for a longer time, thus permitting moisture loss from the pulp. It has been noted that as skin dries and hardens there is less loss in moisture from the pulp as the movement of moisture is retarded by the drying of the skin.

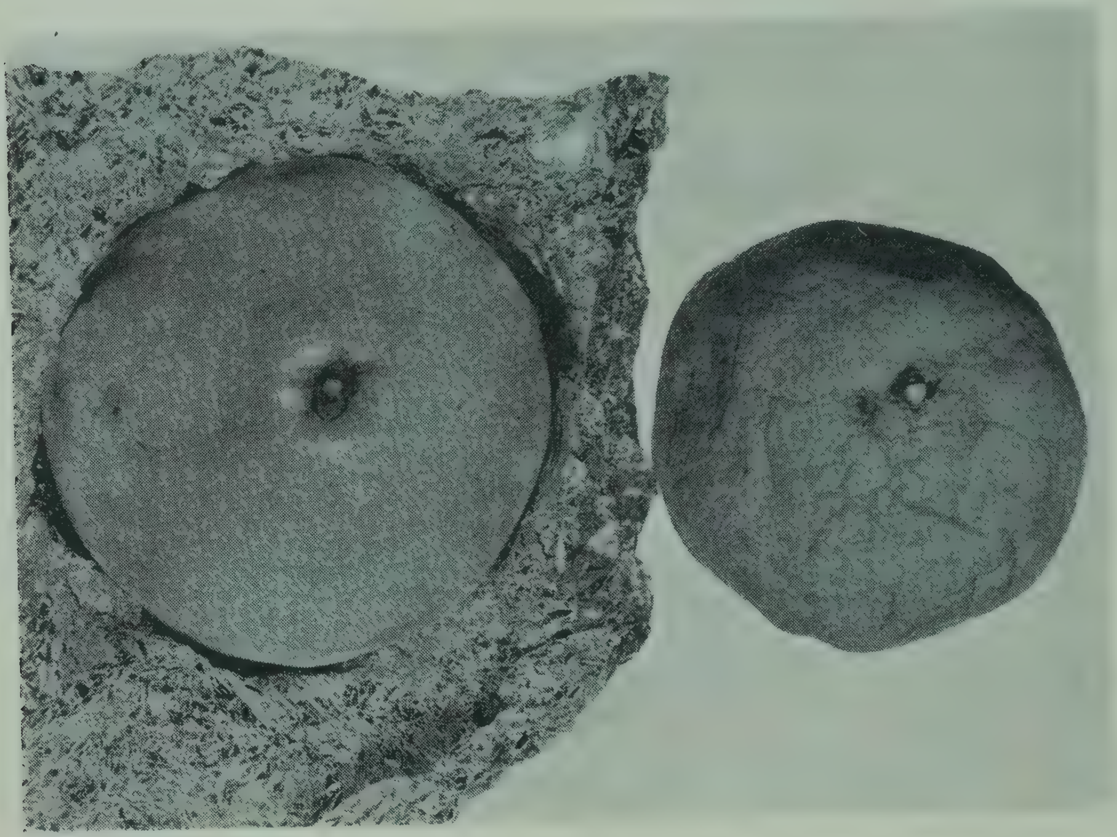

Fig. 21.—Typical Silver Cluster grapefruit after five months' storage at 37½°F. wrapped in plain aluminum foil .00065" and not wrapped.

The figures of the table show that the most efficient wrappers with regard to weight retention are the aluminum foil (.00065 gauge and gauge .00045) and M. T. cellophane (moistureproof). (Figs. 22 and 23.) Fruit wrapped in the other wrappers lost from three to 20 times as much weight at the various temperatures as did that wrapped in the three best wrappers mentioned above. Considering the effect of temperature, loss in weight is in direct relation to temperature. The lower the temperature, the less loss in weight. This is true of the fruit in all wrappers and that not wrapped.

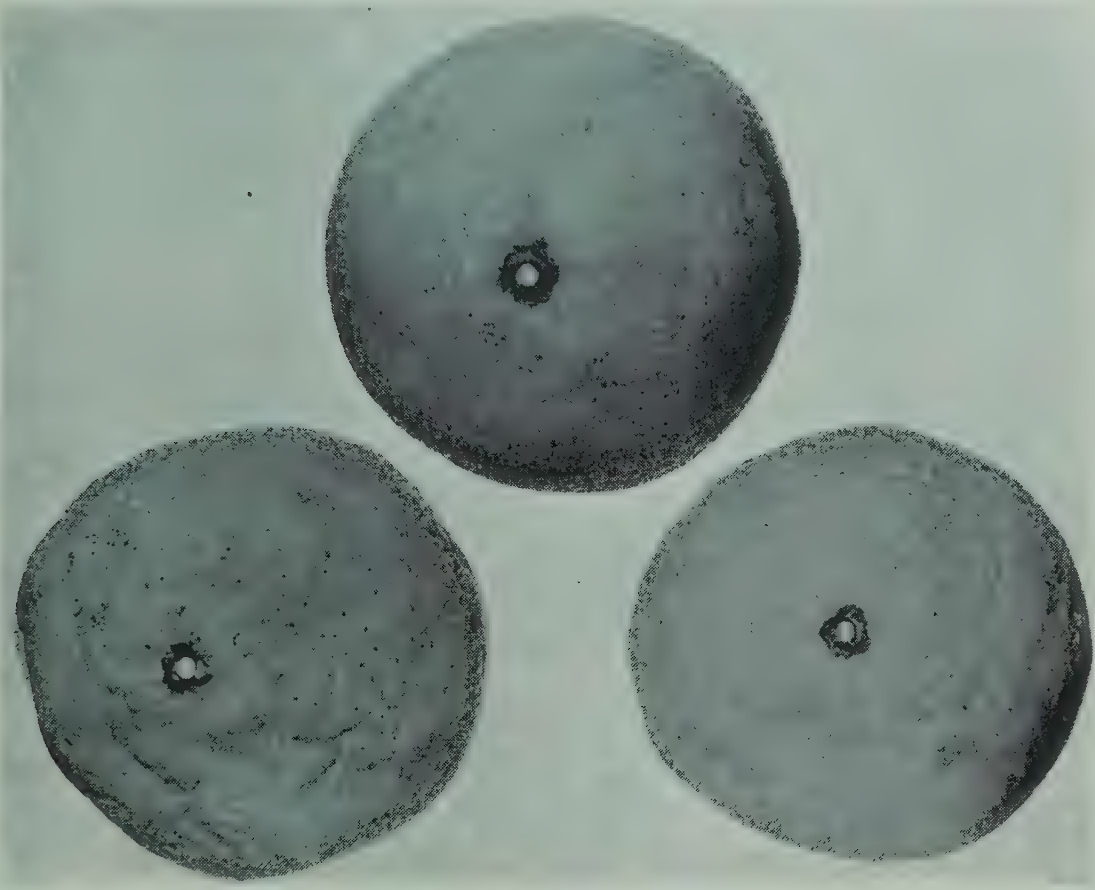

Fig. 22.—Typical Silver Cluster grapefruit after five months' storage at room temperature, showing effect of moisture-retentiveness of wrapper. Top, moistureproof cellophane; bottom, P. T. cellophane (left), and semi-moistureproof S. A. T. cellophane.

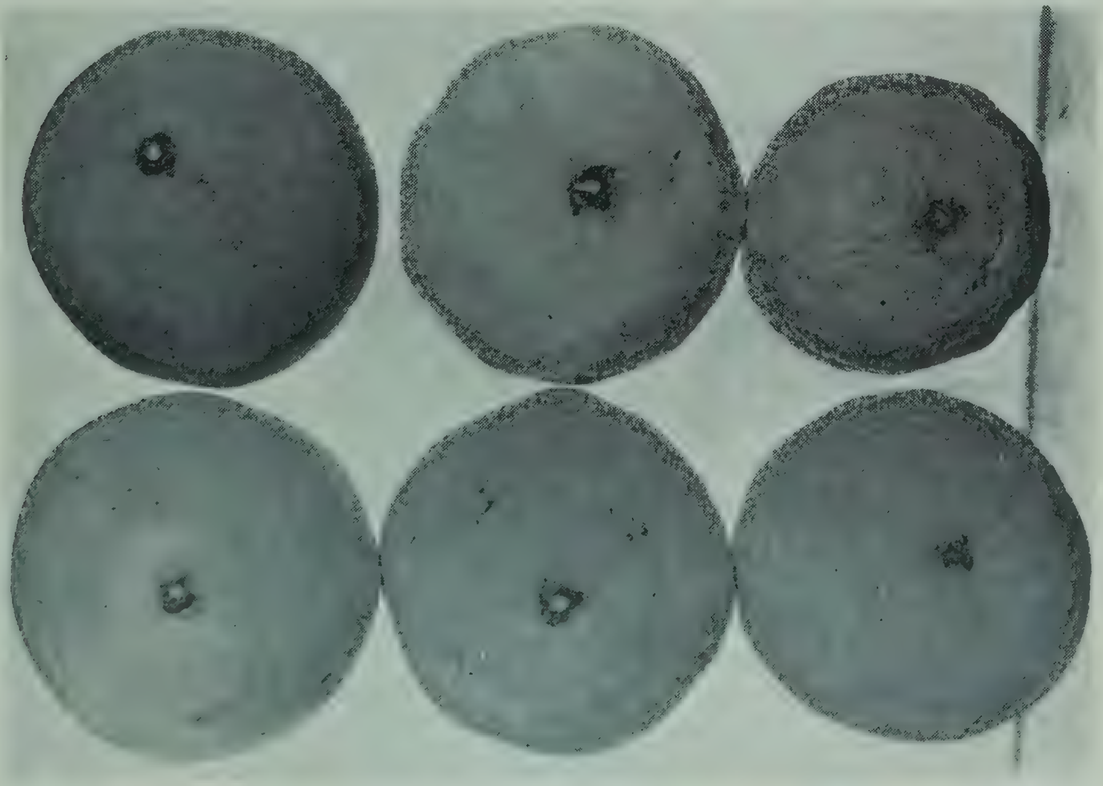

Fig. 23.—Silver Cluster grapefruit after five months' storage at 37½°F. wrapped in the following wrappers: Left to right, top row—M. T. cellophane, parchment, no wrap; bottom row—plain aluminum 65, waxed paper and tissue.

TABLE 18.—TOTAL LOSS IN WEIGHT OF SILVER CLUSTER GRAPEFRUIT IN STORAGE. (AVERAGE* OF ALL FRUIT AT 4 LOWEST TEMPERATURES, 32°, 37½°, 42° AND 48°.)

Wrapper	After 1 Month		After 2 Months		After 3 Months		After 4 Months		After 5 Months	
	gms.	percent	gms.	percent	gms.	percent	gms.	percent	gms.	percent
Aluminum foil (.00065)	1.4	0.28	2.3	0.48	3.6	0.75	4.9	1.02	6.3	1.41
Aluminum foil (.00045)	1.6	0.33	2.8	0.57	4.8	0.99	6.5	1.32	8.6	1.78
M. T. cellophane	2.2	0.43	3.8	0.78	7.0	1.41	10.1	2.06	13.1	2.78
S. S. T. cellophane	8.7	1.80	15.6	3.18	23.1	4.68	30.4	6.21	39.1	8.06
Wet waxed paper	8.0	1.70	15.9	3.38	23.9	4.10	32.5	6.81	42.1	8.70
White eagle parchment	9.4	1.85	17.5	3.41	26.0	5.04	34.9	6.63	45.3	8.55
Household waxed paper	8.8	1.77	16.8	3.41	25.6	5.12	34.4	6.79	44.4	8.68
Prosperity parchment	12.2	2.51	21.9	4.46	31.9	6.50	46.9	8.52	53.8	10.62
Plain tissue	16.6	3.50	29.7	6.25	42.5	8.99	55.3	11.51	69.6	14.66
P. T. cellophane	17.6	3.65	30.5	6.43	43.9	9.09	56.7	11.61	70.8	14.58
None	17.5	3.58	31.4	6.45	44.7	9.02	58.4	11.51	74.0	14.61
Average	9.4	1.94	17.1	3.51	25.2	5.15	33.3	6.73	42.5	8.59

*All figures in table are averages of 100 fruits.

Table 18 gives the averages of the four coldest temperatures. The figures of this table bring out even more clearly the superiority of the aluminum foil and moistureproof cellophane wrappers with regard to weight retentiveness in grapefruit. They also show the wet waxed paper wraps to be equal to the S. S. T. cellophane wraps in this regard. Figure 24 shows the superiority of the moistureproof wrappers over the other wrappers used with regard to retention of weight and quality.

Pitting.—The pitting examinations were made by recording the number of fruits in each wrapper showing (a) no pitting, (b) slight pitting, (c) moderate pitting and (d) bad pitting. In order to present the data in less complicated form, arbitrary score values were assigned to the above classes as follows:

No pitting	100 points
Slight pitting	80 points
Moderate pitting	60 points
Bad pitting	40 points

The sum of the individual scores was divided by the number of fruits examined to obtain the average score of the lot.

Data showing the effect of various wrappers on the storage pitting of Silver Cluster grapefruit are presented in Table 19. Over the entire storage period and at all of the various storage temperatures the moistureproof cellophane and aluminum foils, together with the wet waxed paper, were most efficient in reducing or retarding pitting. There was considerable variation in the effect of the other wrappers in this regard at the different temperatures. Tissue wraps had little effect on pitting. Fruit in the other paper wraps and lighter grades of cellophane averaged significantly less pitting at any one time during the storage period than did the unwrapped fruit.

The figures of Table 19 also show the effect of temperature on pitting. It is severe at the colder temperatures, decreasing in both amount and severity in the storage rooms at higher temperatures. The figures indicate that the temperature has more effect than the wrapper on pitting. Pitting gradually became more severe as the storage period increased and as the number of days the fruit was kept after removal from storage increased. The increase in the latter case, however, was not very great but appeared to be great, due to the fact that the pits became discolored more quickly after the fruit was removed from storage and the fruit was more vulnerable to secondary infections through the pitted areas at this time. The pitting was more severe in the grapefruit than in the oranges. It appeared in the grapefruit much sooner and spread more rapidly. The higher temperatures have a curing effect on the fruit and this hardening of the rind seems to decrease pitting in the fruit held at these temperatures.

TABLE 19.—EFFECT OF VARIOUS WRAPPERS AND TEMPERATURES ON AMOUNT AND SEVERITY OF STORAGE PITTING ON SILVER CLUSTER GRAPEFRUIT.

Temp.	Wrapper	Amount of Storage Pitting*				
		After 1 Month	After 2 Months	After 3 Months	After 4 Months	After 5 Months
32°F.	Plain aluminum 65	100	90	88	85	80
	M. T. cellophane	95	94	85	82	80
	Plain aluminum 45	95	93	83	80	78
	Wet waxed	94	90	88	83	75
	S. S. T. cellophane	92	92	87	80	70
	Household waxed	93	90	78	78	71
	P. T. cellophane	91	81	78	70	68
	Tissue wrap	91	87	75	68	64
	Prosperity parchment	90	78	75	67	56
	White eagle parchment	92	80	72	58	45
	None	100	100	71	38	35
37½°F.	Plain aluminum 65	94	89	88	82	78
	Plain aluminum 45	92	87	82	78	70
	Wet waxed	100	92	80	70	67
	M. T. cellophane	95	90	76	72	59
	P. T. cellophane	91	85	81	69	58
	White eagle parchment	90	82	70	65	52
	Plain tissue	93	75	71	59	49
	Household waxed	91	79	78	65	40
	S. S. T. cellophane	92	72	58	40	28
	None	88	70	37	39	25
	Prosperity parchment	87	58	55	36	20
42°F.	Plain aluminum 45	100	90	89	87	85
	M. T. cellophane	100	100	92	86	80
	Plain aluminum 65	95	94	92	85	77
	S. S. T. cellophane	100	90	90	86	70
	Wet waxed	100	90	88	84	68
	Household waxed	100	87	80	80	70
	Prosperity parchment	100	85	78	76	64
	White eagle parchment	100	81	75	72	66
	P. T. cellophane	100	78	71	68	69
	None	96	70	63	64	60
	Plain tissue	94	68	65	65	45

TABLE 19.—EFFECT OF VARIOUS WRAPPERS AND TEMPERATURES ON AMOUNT AND SEVERITY OF STORAGE PITTING ON SILVER CLUSTER GRAPEFRUIT.—*Continued.*

Temp.	Wrapper	Amount of Storage Pitting*				
		After 1 Month	After 2 Months	After 3 Months	After 4 Months	After 5 Months
48°F.	M. T. cellophane	100	100	100	100	100
	Plain aluminum 45	100	100	100	100	95
	Plain aluminum 65	100	100	100	100	90
	Wet waxed	100	98	97	95	85
	Prosperity parchment	100	97	97	90	80
	White eagle parchment	100	95	92	88	78
	S. S. T. cellophane	100	98	88	80	78
	Household waxed	100	87	86	85	76
	P. T. cellophane	100	85	81	80	77
	None	95	85	80	77	75
	Plain tissue	95	81	78	76	74
54°F.	Plain aluminum 65	100	100	100	100	100
	Wet waxed	100	100	100	100	100
	Plain aluminum 45	100	100	100	100	97
	M. T. cellophane	100	100	100	100	90
	S. S. T. cellophane	100	100	100	98	90
	White eagle parchment	100	100	95	96	90
	Prosperity parchment	100	100	94	92	86
	Plain tissue	100	98	90	90	86
	None	100	96	88	86	82
	P. T. cellophane	100	92	85	84	80
	Household waxed	98	90	85	82	80
58°F.	M. T. cellophane	100	100	100	100	100
	Plain aluminum 45	100	100	100	100	100
	Wet waxed	100	100	100	100	100
	Plain aluminum 65	100	100	100	100	100
	Prosperity parchment	100	100	100	100	100
	S. S. T. cellophane	100	100	98	95	95
	White eagle parchment	100	100	96	92	90
	Household waxed	100	98	95	90	90
	P. T. cellophane	100	96	90	88	87
	None	100	96	88	85	82
	Plain tissue	100	95	85	80	75
Room Temp. (70-80°F.)	Plain aluminum 65	100	100	100	100	100
	Prosperity parchment	100	100	100	100	100
	Plain aluminum 45	100	100	100	99	98
	Wet waxed	100	99	95	95	97
	M. T. cellophane	100	99	95	94	95
	White eagle parchment	100	98	95	93	93
	P. T. cellophane	100	97	95	90	90
	Household waxed	100	97	90	83	85
	S. S. T. cellophane	98	95	90	85	83
	Plain tissue	95	94	90	85	82
	None	95	94	90	85	80

*Score Values:	No pitting	100
	Slight pitting	80
	Moderate pitting	60
	Bad pitting	40

Decay.—The only appreciable decay encountered during the course of the experiment with grapefruit, as with oranges, was of two types, Penicillium mold and stem-end rot. Both green (*Penicillium italicum*) and blue mold (*Pencillium digitatum*) and one stem-end rot organism (*Phomopsis citri*) were encountered.

The figures of Table 20 for the percent decay indicate a decided effect of temperature on the amount and severity of decay. The figures show very little decay of grapefruit in any of the wrappers at the lower temperatures (32° and 37½° F.), but show much decay at the higher temperatures (54° and 58° F.). The figures indicate that there is a direct correlation between decay and temperature; the higher the temperature, the higher the percentage decay of the fruit.

The effect of the wrappers on decay is much less pronounced. The wrappers are arranged in the table in order of their efficiency to prevent decays at each temperature. The efficiency varied for the wraps at the different temperatures; that is, no one wrapper was consistently good or consistently bad at all of the temperatures but would be good at one, medium at another and bad at a third. The moisture retentive wrappers were no more efficient in prevention of decay than the paper wraps. At some of the temperatures the unwrapped fruit developed less decay than the wrapped fruit. Temperature and not wrappers is the controlling factor in the retarding or prevention of decay in cold storage.

Stem-end rot was the more prevalent of the decays, there being very little Penicillium mold of either type.

General Appearance.—Firmness, wrinkling, drying out, pitting, and color were all taken into consideration in judging the fruit for its general appearance. Taste was also considered in the score values given in Table 21. A fruit was classed as (1) good, when it could not be distinguished in appearance or taste from fresh fruit; (2) fair, when it was still marketable but somewhat inferior in quality and taste to fresh fruit; and (3) bad, when it was no longer marketable. A similar method of scoring to that used for pitting was applied to simplify the data. The arbitrary score values assigned were as follows:

Good	100 points
Fair	70 points
Bad	0 points

The sum of the individual scores was divided by the number of fruit examined to obtain the average score of the sample.

TABLE 20.—EFFECT OF VARIOUS WRAPPERS AND TEMPERATURES ON AMOUNT AND SEVERITY OF DECAY ON SILVER CLUSTER GRAPEFRUIT.

Temp.	Wrapper	Percent Decay				
		After 1 Month	After 2 Months	After 3 Months	After 4 Months	After 5 Months
32°F.	Prosperity parchment	0.0	0.0	0.0	0.0	3.3
	Household waxed	0.0	0.0	0.0	0.0	10.0
	White eagle parchment	0.0	0.0	0.0	0.0	10.0
	Plain tissue	0.0	0.0	0.0	3.3	6.7
	Wet waxed	0.0	0.0	0.0	3.3	10.0
	P. T. cellophane	0.0	0.0	0.0	0.0	16.7
	None	0.0	0.0	0.0	0.0	23.3
	S. S. T. cellophane	0.0	0.0	0.0	3.3	26.7
	Plain aluminum 45	0.0	0.0	0.0	0.0	60.0
	M. T. cellophane	0.0	0.0	0.0	3.3	63.3
	Plain aluminum 65	0.0	0.0	0.0	10.0	83.3
37½°F.	Prosperity parchment	0.0	0.0	0.0	3.3	10.0
	Wet waxed	0.0	0.0	0.0	3.3	16.7
	White eagle parchment	0.0	0.0	0.0	6.7	13.3
	P. T. cellophane	0.0	0.0	0.0	6.7	16.7
	Household waxed	0.0	3.3	6.7	6.7	6.7
	Plain aluminum 65	0.0	0.0	0.0	3.3	20.0
	S. S. T. cellophane	0.0	0.0	0.0	6.7	26.7
	M. T. cellophane	0.0	0.0	0.0	10.0	20.0
	Plain tissue	0.0	0.0	3.3	10.0	23.3
	Plain aluminum 45	0.0	0.0	0.0	6.7	26.7
	None	0.0	0.0	0.0	10.0	40.0
42°F.	White eagle parchment	0.0	0.0	3.3	10.0	36.7
	Plain aluminum 45	0.0	0.0	0.0	3.3	43.3
	Household waxed	0.0	3.3	3.3	10.0	46.7
	M. T. cellophane	0.0	0.0	0.0	13.3	43.3
	Plain aluminum 65	0.0	3.3	6.7	10.0	53.3
	Prosperity parchment	0.0	0.0	0.0	10.0	50.0
	Wet waxed	0.0	0.0	0.0	13.3	63.3
	S. S. T. cellophane	0.0	3.3	3.3	16.7	63.3
	P. T. cellophane	0.0	0.0	0.0	20.0	56.7
	Plain tissue	0.0	0.0	0.0	13.3	80.0
	None	0.0	0.0	3.3	33.3	66.7
48°F.	Prosperity parchment	0.0	3.3	40.0	50.0	63.3
	Plain tissue	0.0	3.3	33.3	66.7	70.0
	None	0.0	0.0	43.3	70.0	80.0
	Household waxed	0.0	6.7	50.0	63.3	80.0
	S. S. T. cellophane	3.3	6.7	56.7	80.0	80.0
	Plain aluminum 45	0.0	16.7	43.3	53.3	66.7
	White eagle parchment	0.0	10.0	43.3	56.7	66.7
	Wet waxed	3.3	13.3	50.0	66.7	76.7
	Plain aluminum 65	3.3	20.0	66.7	70.0	76.7
	P. T. cellophane	0.0	13.3	53.3	73.3	80.0
	M. T. cellophane	0.0	23.3	56.7	80.0	86.7

TABLE 20.—EFFECT OF VARIOUS WRAPPERS AND TEMPERATURES ON AMOUNT AND SEVERITY OF DECAY ON SILVER CLUSTER GRAPEFRUIT.—*Continued.*

Temp.	Wrapper	Percent Decay				
		After 1 Month	After 2 Months	After 3 Months	After 4 Months	After 5 Months
54°F.	Plain aluminum 45	3.3	33.3	43.3	46.7	50.0
	None	3.3	20.0	50.0	63.3	70.0
	P. T. cellophane	0.0	26.7	60.0	73.3	86.7
	S. S. T. cellophane	0.0	30.0	53.3	73.3	76.7
	Prosperity parchment	0.0	26.7	73.3	73.3	83.3
	Household waxed	3.3	33.6	70.0	76.7	86.7
	M. T. cellophane	0.0	50.0	56.7	56.7	66.7
	Plain aluminum 65	0.0	43.3	66.7	70.0	73.3
	White eagle parchment	3.3	40.0	60.0	70.0	70.0
	Plain tissue	0.0	40.0	60.0	83.3	86.7
	Wet waxed	0.0	33.3	73.3	86.7	96.7
58°F.	Plain aluminum 45	0.0	36.7	46.7	53.3	......
	Plain aluminum 65	0.0	46.7	50.0	53.3	......
	Plain tissue	0.0	40.0	53.3	56.7	......
	None	0.0	33.3	56.7	70.0	......
	White eagle parchment	3.3	50.0	53.3	63.3	......
	P. T. cellophane	3.3	56.7	70.0	76.7	......
	Household waxed	0.0	56.7	66.7	76.7	......
	Prosperity parchment	0.0	40.0	70.0	80.0	......
	Wet waxed	13.3	60.0	66.7	70.0	......
	S. S. T. cellophane	3.3	63.3	73.3	73.3	......
	M. T. cellophane	0.0	53.3	80.0	83.3	......
Room Temp. (70-80°F.)	None	0.0	36.7	53.3	56.7	60.0
	Plain aluminum 45	6.7	43.3	60.0	63.3	63.3
	Household waxed	0.0	50.0	63.3	63.3	66.7
	Plain tissue	3.3	43.3	70.0	70.0	70.0
	S. S. T. cellophane	3.3	63.3	66.7	70.0	73.3
	M. T. cellophane	3.3	53.3	66.7	70.0	73.3
	Wet waxed	0.0	50.0	60.0	63.3	76.7
	Plain aluminum 65	8.0	46.7	56.7	66.7	73.3
	P. T. cellophane	3.3	46.7	56.7	63.3	80.0
	White eagle parchment	6.7	60.0	76.7	80.0	83.3
	Prosperity parchment	6.7	53.3	70.0	86.7	93.3

Table 21 contains the values for fruit directly on removing from storage, five days after removal and 10 days after removal at intervals of one month for fruit held at the lowest four temperatures. The wrappers are arranged according to their efficiency in keeping a good general appearance and taste in the fruit.

An examination of Table 21 shows that the moistureproof wrappers (aluminum foils and M. T. cellophane) are much superior in preserving general appearance to all other wraps used, with S. S. T. cellophane proving the next best, it being a semi-moistureproof wrapper. Next were the waxed papers, then

TABLE 21.—RELATIVE EFFECT OF VARIOUS WRAPPERS ON GENERAL APPEARANCE AND TASTE OF SILVER CLUSTER GRAPEFRUIT (AVERAGE OF FRUIT FROM FOUR TEMPERATURES)[1].

Wrapper	One Month Storage				Two Months Storage				Three Months Storage				Four Months Storage				Average of All Storage Periods			
	Days after Removal				Days after Removal				Days after Removal				Days after Removal				Days after Removal			
	0	5	10	Avg.	0	5	10	Avg.	0	5	10	Avg.	0	5	10	Avg.	0	5	10	Avg.
Plain aluminum 45	100	97	93	97	100	95	90	95	98	85	80	88	80	70	60	70	95	87	81	88
M. T. cellophane	100	95	90	95	98	95	90	94	92	77	70	80	78	70	62	70	92	84	78	85
Plain aluminum 65	98	97	90	95	96	90	85	90	90	78	70	79	72	65	63	67	89	83	77	83
S. S. T. cellophane	92	82	70	81	86	82	80	84	85	72	65	74	64	50	45	53	82	72	65	73
Wet waxed	80	72	70	74	80	78	72	77	72	68	65	68	60	42	40	47	73	65	62	67
Household waxed	78	75	72	75	75	70	70	72	70	68	66	68	55	39	30	41	70	63	60	64
White eagle parchment	78	75	68	74	70	60	50	62	66	54	50	57	55	40	20	38	67	57	47	57
Prosperity parchment	75	59	55	63	70	66	40	59	62	48	42	51	58	32	10	33	66	51	37	51
Plain tissue	76	60	55	64	70	65	40	58	58	46	38	47	50	28	5	28	64	50	35	50
None	72	68	50	63	65	50	35	50	59	48	32	46	45	12	0	19	60	45	29	45
P. T. cellophane	70	69	50	63	66	48	30	48	60	40	32	44	45	10	0	18	60	42	28	43

Score Value: Good 100
Fair 70
Bad 0

[1] 32°, 37½°, 42° and 48°F.

the parchment papers and last the plain tissue, no wrapper and P. T. cellophane. Waxed paper kept the fruit in a much better condition than the other paper wraps.

After removal from storage the deterioration is quite rapid. It appears that the depreciation of those fruits wrapped in the moistureproof wrappers was consistently less than those in the other wraps and those unwrapped. The longer the fruit is held in storage the more quickly it deteriorates when removed from storage. There was considerable falling off in quality as the storage period increased. Pitted fruit deteriorated more quickly than that not pitted, the pits serving as points of infection for fungi.

The taste did not change until after the third month of storage when the fruit took on a mild storage flavor which increased with the length of the storage period and the time after removal from storage.

The temperature, of course, had an effect on general appearance. Drying out of the fruit held at the higher temperatures was as important and effective a factor in detracting from the general appearance of the fruit as was pitting at the lower temperatures. The fruit in those wrappers which prevented excessive drying out at the warmer temperatures (42° and above) had an excellent general appearance while fruit in which the pitting was retarded at the lower temperatures had an excellent appearance even after four months' storage. After removal from storage the fruit from 32° F. did not hold up so well as the fruit from the higher temperatures. The higher the storage temperature the better and longer the fruit kept when removed from storage to room temperature.

MISCELLANEOUS OBSERVATIONS

Color.—The color of the fruit was affected only indirectly. As the fruit became dried and shriveled in appearance it developed a duller shade.

Temperature had more effect than the wrapper on color. At the higher temperatures the fruit became noticeably deeper in color. There was a noticeable difference in color in all of the grapefruit varieties tested, between fruit at 37½° and 42°, with the difference becoming even more marked between 42° and 48° F. The deep color that the grapefruit takes on at the higher storage temperatures may prove detrimental on the market.

Taste.—All fruit at each examination was systematically tasted. None of the wrappers showed a direct detrimental effect on the taste of the fruit. As the fruit became dried and old, however, it developed a taste characteristic of over-ripe fruit.

After about three months' storage most of the fruit had begun to lose its "fresh" taste and flavor, but sound, firm fruit seldom developed objectionable taste. Fruit held in storage for a considerable period of time tended to develop an "old" taste much sooner after removal than that held for shorter periods.

Sweating After Removal.—The paper wraps became thoroughly soaked through in about an hour after the fruit was removed from storage, due to the sweating of the fruit. Moisture would condense within the moistureproof wrappers, very little in the aluminum foils and much in the others. Most of this condensed moisture was present within the moistureproof and semi-moistureproof wrappers before removal from the refrigeration rooms. The moistureproof wrappers retained this condensed moisture inside the wrapper for several days after removal from the cold rooms.

SUPPLEMENTARY EXPERIMENTS

Moistureproof Lining of Citrus Storage Crates.—As in the experiments with oranges, large bags which would fit the half of a commercial citrus box and allow sufficient top for sealing and folding over were made from the various suitable moistureproof wrapping materials and used as box liners with grapefruit. The expense of the moistureproof wrappers has been a barrier to their commercial use and this trial of the moistureproof box liner was made with a view to reducing this cost and still retaining benefits of a moistureproof wrapper. In a box packing 54 fruit, one-sixth as much wrapping material was used in lining the box as when individual wrappers were used.

The effects of the various wrappers and cellophane lined containers on the loss in weight of McCarty grapefruit stored at 37½° F. over a five months' storage period are shown in Table 22. The loss in weight in kilograms and percent for every two weeks is given.

When comparing the box liner with the individual wrap in regard to loss in weight it is readily seen that the box liner is as efficient as the individual wrap. The M. T. cellophane was the most efficient in this regard as a box liner and also as an individual wrap. The combination of ordinary tissue wraps and

TABLE 22.—EFFECT OF VARIOUS WRAPPERS AND BOX LININGS ON THE LOSS IN WEIGHT OF MCCARTY GRAPEFRUIT STORED AT 37½°F.

Box Lining	Fruit Wrapper	After 2 Wks.		After 4 Wks.		After 6 Wks.		After 8 Wks.	
		Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss
None	None	0.75	1.37	1.50	2.74	2.25	4.15	2.75	5.09
None	Tissue	0.25	0.50	0.75	1.51	1.50	3.02	2.50	5.03
None	S. S. T. cellophane	0.25	0.48	0.75	1.46	1.25	2.49	2.00	4.04
None	Al. foil .00045	0.75	1.45	0.75	1.45	0.75	1.45	1.00	1.94
S. S. T. cellopahne	None	0.50	0.91	0.50	0.91	1.00	1.83	1.25	2.28
S. S. T. cellophane	Tissue	0.25	0.49	0.25	0.49	1.00	1.99	1.00	1.99

Box Lining	Fruit Wrapper	After 10 Wks.		After 12 Wks.		After 14 Wks.		After 16 Wks.	
		Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss	Loss in wt. (lbs.)	% Loss
None	None	3.00	5.62	4.00	7.75	4.75	10.17	5.25	11.78
None	Tissue	2.50	5.03	3.50	7.34	4.25	9.47	4.75	10.89
None	S. S. T. cellophane	2.75	5.76	3.25	6.91	3.50	7.93	4.00	9.97
None	Al. foil .00045	1.25	2.54	1.50	3.14	1.75	3.92	2.25	5.47
S. S. T. cellophane	None	1.50	2.79	2.25	4.32	3.25	6.26	4.00	9.17
S. S. T. cellophane	Tissue	1.00	1.99	1.75	3.54	2.00	4.26	2.50	5.72

semi-moistureproof liner proved to be as satisfactory with grapefruit as with oranges, but was not so efficient as the moistureproof liner alone or when used with tissue wrapped fruit.

Table 23 is a tabulation of the effect of various wrappers and box liners on the keeping quality of McCarty grapefruit. The percent decay and percent good fruits are given after every month's storage at 37½° F. The grapefruit kept splendidly in the S. S. T. cellophane box lining. It will be noted from the values given in the table that the fruit in the box liner bags kept much better than the fruit packed with no box liner. For the first three months of storage the percent decay was greater in the fruit wrapped individually in S. S. T. cellophane than when they were packed with plain tissue or without a wrapper and only a box liner of S. S. T. cellophane was used. It is also apparent that the decay was higher under the moisture-retentive liner and wrapper than it was under the semi-moisture-retentive liner and wrapper.

Comparison of Additional Wrappers and Box Liners.—A number of new wrapping materials were tried on a large number of grapefruit during the 1934-35 season, both as individual wrappers and as liners to the packing box. Ten boxes of Walters grapefruit were wrapped in each of the following wrappers or box liners: Moistureproof cellophane, moistureproof sylphrap, S. A. T. cellophane, plain tissue and no wrap. They were packed in the regular Florida citrus crates, using the commercial packing designs, or were packed in the crates lined with transparent moistureproof wrapping material and sealed and stored at 42° F.

The effect of various wrappers and moistureproof lined crates on the loss of weight of Walters grapefruit stored at 42° F. over a 20-week period is given in Table 24. The moistureproof wrappers were by far the most efficient in preventing loss in weight, the moistureproof cellophane being slightly superior to moistureproof sylphrap, with the S. A. T. cellophane next and with tissue only slightly more efficient than no wrapper.

When comparing the box liner with the single wrapper it is readily seen that the box liner was as efficient as the single wrapper with regard to loss in weight. Here, as with oranges, the combination of ordinary tissue wraps and the moistureproof liner proved to be very satisfactory. When tissue was not used, "nesting" occurred more readily and a higher percentage loss from decay was obtained.

TABLE 23.—Effect of Various Wrappers and Cellophane-Lined Containers on the Keeping Quality of McCarty Grapefruit Stored at 37½°F.

Box Lining	Fruit Wrapper	After 1 Month		After 2 Months		After 3 Months		After 4 Months	
		% Good Fruit	% Decay	% Good Fruit	% Decay	% Good Fruit	% Decay	% Good Fruit	% Decay
None	None	97.37	2.63	86.84	13.16	52.63	47.37	11.84	88.16
None	Tissue	100.00	0.00	87.14	12.86	68.57	31.43	27.14	72.86
None	S. S. T. cellophane	95.71	4.29	84.29	15.71	45.71	54.29	7.15	92.85
None	Al. foil .00045"	98.59	1.41	78.87	21.13	39.44	60.56	2.82	97.18
S. S. T. cellophane	None	100.00	0.00	89.16	10.84	43.37	56.63	4.82	95.18
S. S. T. cellophane	Tissue	98.57	1.43	94.29	5.71	65.71	34.29	5.71	94.29

TABLE 24.—EFFECT OF VARIOUS WRAPPERS AND MOISTUREPROOF BOX LININGS ON LOSS IN WEIGHT OF WALTERS GRAPEFRUIT STORED AT 42°F. AFTER:*

Box Lining	Wrapper	2 wks.		4 wks.		6 wks.		8 wks.		10 wks.	
		kgs.	%	kgs.	%	kgs.	%	kgs.	%	kgs.	%
M. P. cellophane	Tissue	.00	.00	.00	.00	.01	.04	.10	.42	.12	.51
M. P. cellophane	None	.00	.00	.00	.00	.00	.00	.01	.04	.04	.15
None	M. P. sylphrap	.02	.07	.05	.18	.18	.65	.50	1.81	.61	2.21
None	S. T. A. cellophane	.30	1.10	.53	1.94	.68	2.49	1.04	3.81	1.19	4.36
None	Tissue	.45	1.93	.55	2.36	.85	3.64	1.34	5.74	1.54	6.60
None	None (check)	.49	1.68	.77	2.64	1.18	4.05	1.89	6.48	2.13	7.30

Box Lining	Wrapper	12 wks.		14 wks.		16 wks.		18 wks.		20 wks.	
		kgs.	%	kgs.	%	kgs.	%	kgs.	%	kgs.	%
M. P. cellophane	Tissue	.22	.94	.32	1.37	.38	1.63	.38	1.63	.38	1.63
M. P. cellophane	None	.14	.51	.33	1.20	.51	1.85	.53	1.92	.58	2.10
None	M. P. sylphrap	1.07	3.88	1.53	5.55	1.91	6.93	2.15	7.80	2.28	8.27
None	S. T. A. cellophane	1.44	5.28	1.99	7.30	2.38	8.73	2.70	9.90	2.83	10.38
None	Tissue	1.97	8.44	2.47	10.58	2.80	11.99	3.26	13.96	3.54	15.16
None	None (check)	2.19	7.51	2.77	9.50	3.27	11.21	3.84	13.16	4.13	14.15

*The loss in weight due to rots was subtracted each time and the percentages are based on good fruit only.

The percent decay was highest in the moistureproof wrappers and liners and lowest in the check boxes of no wrappers.

Pitting was more severe in the grapefruit than in any of the orange varieties. According to the values given in Table 25, which gives the effect of the various wrappers on pitting of the Walters grapefruit, there was little effect of the wrapper on the amount and severity of pitting.

The above values of Tables 24 and 25 show that the box liner is as efficient as the individual wrap with regard to loss in weight and nearly as efficient with regard to decay and storage pitting. The expense of such costly wrappers as have proved to be beneficial in the cold storage of grapefruit can be greatly reduced without decreasing their efficiency by using the same material as a box liner.

TABLE 25.—EFFECT OF VARIOUS WRAPPERS AND BOX LININGS ON THE PITTING* OF WALTERS GRAPEFRUIT.

Lining Wrapper	1 Month	2 Months	3 Months	4 Months	5 Months
Moistureproof cellophane Tissue	99.3	98.2	97.7	96.5	96.5
None (check) Tissue	97.9	94.5	92.7	90.9	90.9
S. A. T. cellophane None	96.6	95.7	93.1	91.9	91.9
None (check) None	98.1	95.0	91.2	89.2	89.2
Moistureproof sylphrap None	93.5	88.4	88.4	88.4	88.4
Moistureproof cellophane None	99.5	98.6	97.8	86.7	85.0

*Score value for pits per grapefruit: 0-100; 5-90; 10-80; 15-70; 20-60; 25-50.

Commercial Storage of Grapefruit.—One-hundred-and-sixty boxes of Marsh Seedless grapefruit were wrapped, packed, stored and handled in the same manner and at the same time as the Valencia oranges described previously. The quantities of fruit were the same for each kind of wrapper, temperature and package. The grapefruit kept in good condition for three months, while the oranges remained in good condition for five months. In Table 26 is given a tabulation of the percent good and decayed grapefruit, as calculated from the amount of decayed fruit returned by the storekeepers.

The Marsh Seedless grapefruit kept best at a storage temperature of 37½° F. in moistureproof wrappers. Seventy percent of the grapefruit wrapped in moistureproof and semimoistureproof wrappers and stored in April was marketed three or four months later. The majority not marketed was discarded because of decay.

TABLE 26.—KEEPING QUALITY AND MARKETABILITY OF MARSH SEEDLESS GRAPEFRUIT PLACED ON SUMMER MARKET AFTER COLD STORAGE.

Storage Temperature (°F.)	Wrapper	Length of Storage Period (Months)	% Decayed	% Marketed
32	S. S. T. cellophane	3	23	77
32	S. S. T. cellophane	4	37	63
32	Tissue	4	40	*
37½	S. S. T. cellophane	3	20	80
37½	S. S. T. cellophane	4	35	65
37½	Tissue	4	40	*
42	S. S. T. cellophane	3	34	66
42	S. S. T. cellophane	4	50	50
42	Tissue	4	45	*
37½	M. T. cellophane	3	20	80
37½	M. T. cellophane	4	28	72

*Fruit had lost too much weight and was too shriveled to be marketable.

When the experiment was repeated the following year, using 175 boxes of Marsh Seedless grapefruit from Lake Alfred, similar results were obtained with practically the same percentage marketable fruit after three and four months' storage. Considering general appearance, amount of pitting and decay, loss in weight, and taste, the efficiency of the wrappers ranked as follows: plain aluminum foil 45, M. T. cellophane, moistureproof sylphrap, moistureproof kodapak, regular kodapak, S. A. T. cellophane, prosperity parchment, household waxed, oiled, P. T. cellophane, plain tissue and no wrap.

Ten percent more fruit was marketable from the straight packed than from the bulged boxes. The percent decay and physiological breakdown were higher in the bulge than in the straight pack. This fruit, however, was either packed at the point of storage or hauled short distances by truck after packing and not subjected to the long truck or railroad haul of most fruit. The only bruising of the bulge-packed fruit in these experiments came from the lid pressure, while the fruit of the straight pack did not shrink much before storing, and so would not be subjected to the rolling and bruising of the fruit hauled long distances, caused by shrinkage.

The fruit sold fast enough so that very little decayed on the retail stands and the storekeepers were willing to stand this loss when only good, sound fruit was delivered. The fruit was repacked before being placed in the storekeepers' hands, and all decayed and bad fruits were removed.

SUMMARY

The effects of various wrappers and temperatures on the preservation of oranges and grapefruit in storage was studied. Taken into consideration were effect on general appearance, taste, loss in weight, length of time fruit can be held in storage in a marketable condition, occurrence of pitting and decay, and length of time fruit can be held after removal from storage. Twenty-two different wrappers were used, ranging from moisture-proof to those having a very low moisture-retentiveness. Storage temperatures of 32, 37½, 42, 48, 54 and 58° F. and room temperature (70°-80°) were used.

ORANGES

The moistureproof wrappers (aluminum foils, moistureproof grades of cellophane, sylphrap and kodapak) were superior to all other wraps in reducing loss in weight and preserving general appearance of oranges. The semi-moistureproof wrappers (S. S. T. and S. A. T. cellophane and waxed paper) were next best. Whalehide, parchment, oiled paper, regular kodapak, P. T. cellophane, and chemically treated wrappers showed no apparent advantage over the regular tissue wrapped fruit and in some cases were not as efficient. They all showed advantages over no wrappers, however. The percentage loss in weight for the same wrapper in the different experiments with the same variety and for various varieties was consistent.

The S. S. T. and S. A. T. grades of cellophane, regular kodapak (all semi-moistureproof) and sylphrap were better than the other wraps in controlling pitting, but were followed closely in order of effectiveness by oiled and waxed papers which were only slightly more efficient in this respect than the moistureproof wrappers. Fruit in a number of the other wrappers averaged significantly less pitting than did the unwrapped fruit.

Stem-end rot was the most prevalent of the decays. Very little Penicillium mold of both types was found. There is no outstanding difference among the wrappers as to efficiency in controlling decay.

The amount of decay varied directly with temperature, length of storage period, and moisture-retentiveness of the wrapper. At temperatures below 42° F., however, decay in all wraps was negligible.

Comparing the temperature effect, it is clearly indicated that fruit lost more weight at the higher temperatures than at the lower ones. The relationship was direct in that as the temperature increased, the loss in weight from the fruit increased.

Temperature, and not wrappers, was the controlling factor with regard to pitting. The amount of pitting decreased with an increase in temperature.

Quality of the fruit and the general appearance was chiefly affected by loss in weight and pitting.

Fruit of the Pineapple variety was kept in moistureproof wrappers for three to four months in firm condition, while that of the Valencia variety kept for five months. Fruit of both varieties in paper wraps lasted six weeks to two months. The best temperature for both varieties was found to be 37½° F. Valencias kept well at 32° F., but did not stand up so well after removal from storage as that kept at 37½° F. Pitting was high in the Pineapple oranges at 32° F., and at temperatures of 42° F. and above decay was high in fruit of both varieties.

Pineapple oranges showed considerable pitting at the end of one month's storage (especially at the lower temperatures), but Valencia oranges stored five months showed no appreciable evidence of pitting.

Oranges stored at the higher temperatures were noticeably deeper in color than those stored at the lower temperatures. This darker color was not considered detrimental in oranges. Fruit gradually lost its fresh flavor as the storage period increased, but no bad taste could be attributed to any of the wrappers.

The box liner was found to be as efficient as the individual wrapper. The combination of ordinary tissue wraps and semi-moistureproof liner proved to be very satisfactory but not so efficient as the moistureproof liner alone or the moistureproof liner in combination with plain tissue wrappers. In a box packing 150 fruits, one-fifteenth as much wrapping material was used in lining the box as when individual wrappers were used.

Oranges in moistureproof wrappers did not show as rapid deterioration in quality with increase in time out of storage as did those in the various paper wrappers.

Using the wrappers and temperatures found best for storing Valencia oranges a large number (360 boxes) were stored at 37½° F. for four and five months. Eighty-seven percent of the Valencia oranges which were placed in storage in April were marketed four and five months later and purchased in preference to unstored California fruit at the same price. Ten percent more fruit was marketable from the straight than from the bulge-packed boxes. The percent decay was higher in the bulge than straight pack.

GRAPEFRUIT

The mositureproof wrappers (aluminum foils and moistureproof grades of cellophane, sylphrap and kodapak) were superior to all other wraps in reducing loss in weight and preserving general appearance of grapefruit. The semi-moistureproof grades of cellophane were not so efficient as the wet waxed and paper parchment wrappers but were slightly superior to the plain tissue wrap. The wet waxed wrappers were also superior to the parchment papers and the thin grade of cellophane (P. T.).

Pitting was much more severe in all varieties of grapefruit than in oranges. Temperature, and not wrappers, was the controlling factor in the pitting of grapefruit. The moistureproof cellophane and aluminum foils, together with the wet waxed paper, proved most efficient of the wrappers tried in reducing or retarding pitting. Tissue wraps had little effect on pitting. Fruit in any of the wraps averaged significantly less pitting at any one time during the storage period than did the unwrapped fruit.

Efficiency of the wrappers in preventing decay varied for the different temperatures, that is, no one wrapper was consistently good or consistently bad at all of the temperatures. A wrapper would be good at one, medium at another, and bad at a third temperature in this regard. Temperature, and not wrappers, was the controlling factor in the retardation and prevention of decay.

Comparing the temperature effect, it was clearly indicated that fruit lost more weight at the higher temperatures than at the lower ones. Loss in weight was in direct relation to temperature, lower temperatures resulting in less loss.

Storage pitting was found to be severe at the colder temperatures, decreasing in both amount and severity with increase in temperature.

The only appreciable decay encountered during the course of experiment with grapefruit, as with oranges, was of two types: Penicillium mold and stem-end rot. A direct correlation between decay and temperature was found, the higher storage temperatures causing higher percentages of decay.

Grapefruit was kept in good condition for three and four months in moistureproof wrappers, and two and three months in semi-moistureproof wrappers, while that wrapped in plain tissue lasted only six weeks to two months. Fruit gradually lost its fresh flavor as the storage period increased, but no bad taste could be attributed to any of the wrappers. The best temperature for all varieties was found to be 37½° F. At higher temperatures the percent decay was much higher and at lower temperatures the amount of pitting was more severe. The keeping quality of Marsh Seedless grapefruit was equal to that of any other variety.

The box liner was found to be as efficient as the individual wrapper in all respects except in preventing nesting. The combination tissue wrap and moistureproof box lining proved to be most satisfactory. One-sixth as much material was used in box lining as when individual wrappers were used.

In the experiments with fruit packed in commercial crates and considering general appearance, amount of pitting and decay, loss in weight, and taste, the wrappers ranked as follows in efficiency: Plain aluminum foil, M. T. cellophane, moistureproof sylphrap, moistureproof kodapak, regular kodapak, S. A. T. cellophane, prosperity parchment, household waxed, oiled, P. T. cellophane, plain tissue and no wrap.

Using the wrappers and temperatures found best for storing grapefruit, a large number (335 boxes) were stored at 37½° F. Seventy percent of the grapefruit (Marsh Seedless) which were placed in storage in April were marketed four months later. Ten percent more fruit was marketable from the straight than from the bulge-packed boxes.

Fruit wrapped in moistureproof wrappers and held at 37½° F. kept best after removal from cold storage to temperatures of the retail store.

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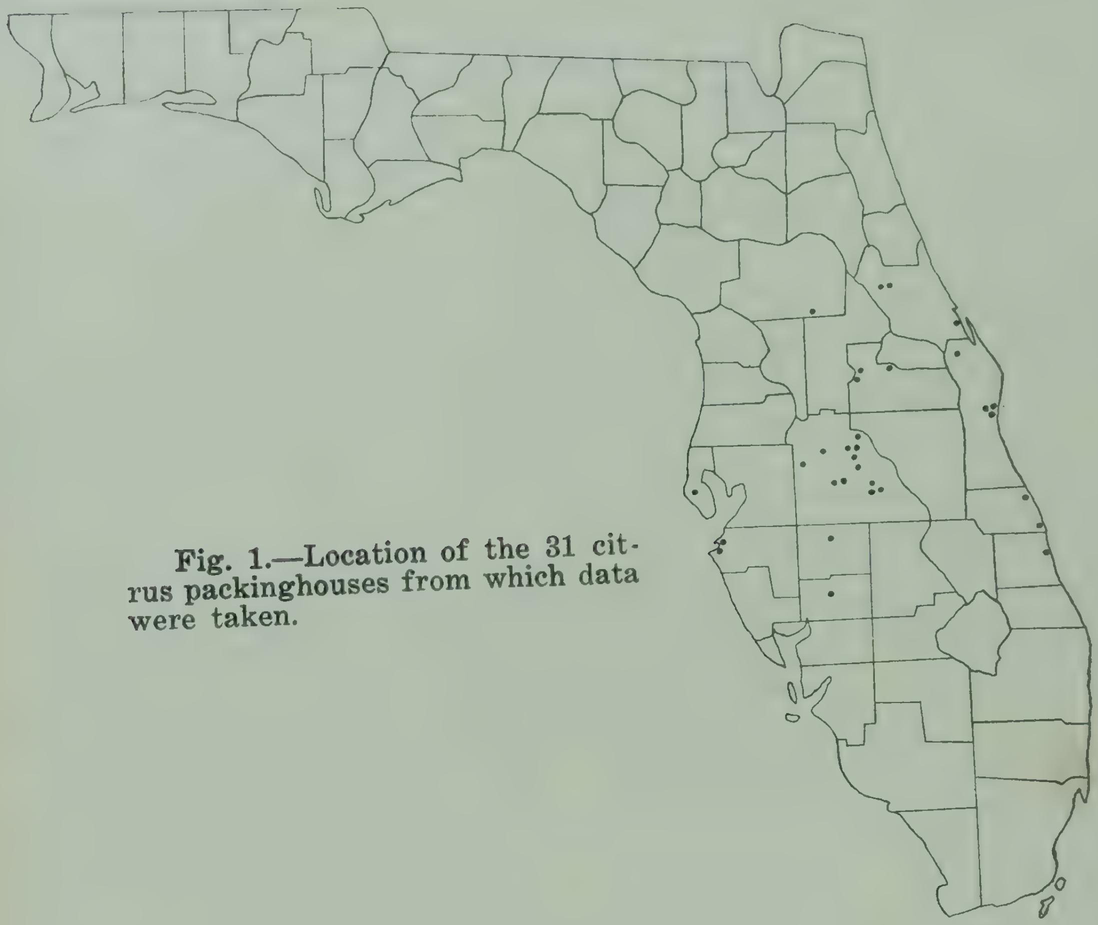

Fig. 1.—Location of the 31 citrus packinghouses from which data were taken.

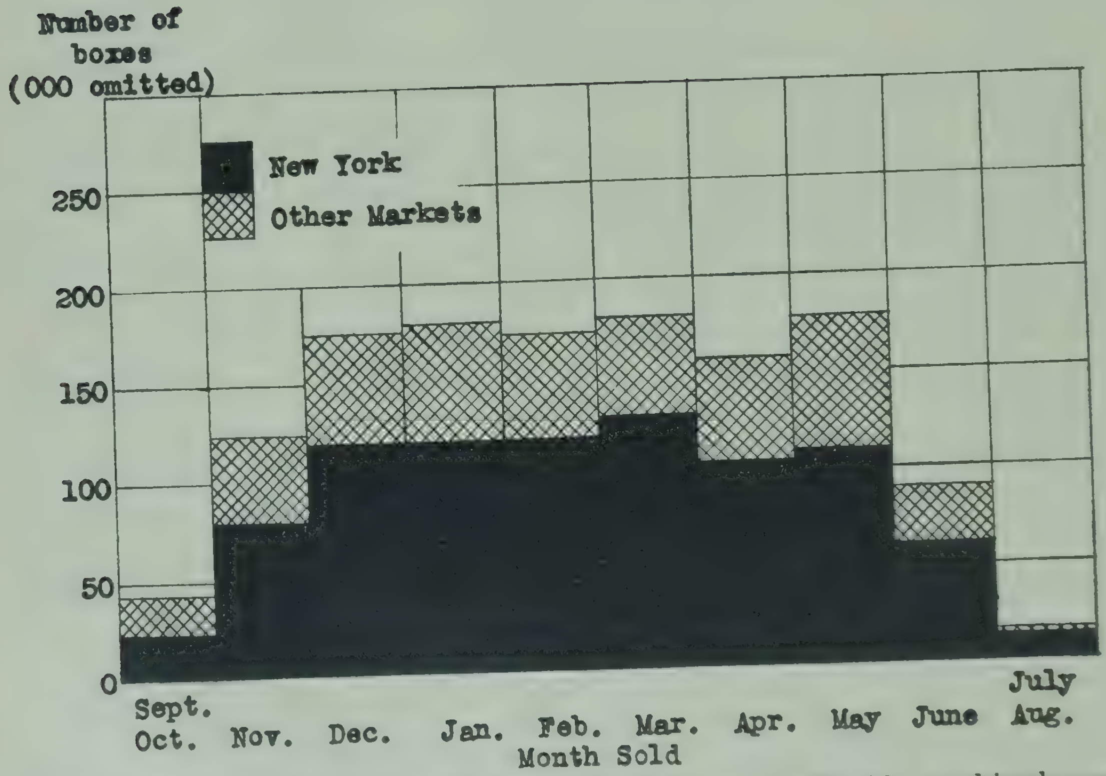

Fig. 2.—Total auction sales of citrus fruit from 31 Florida packinghouses to five markets (average of three seasons, 1930-31, 1931-32, and 1932-33).

FLORIDA CITRUS PRICES, I

By A. H. SPURLOCK and MARVIN A. BROOKER*

INTRODUCTION

The purpose of this study is to present a three-year summary of the average monthly prices received from auction sales for Florida citrus by kinds, by variety, by grade and by size of fruit; to outline the average costs or charges against the fruit which went to auction; and to arrive at the net amount which the shipping agency received from both auction and non-auction sales.

The data include shipments of packed fruit of specified varieties by rail and water from 31 Florida packinghouses to five markets in the United States for auction sales, and to three additional markets for f.o.b. direct and broker sales (Fig. 1). The period of shipment covers the three seasons, 1930-31, 1931-32, and 1932-33. Approximately 11,000 carloads were involved, excluding bulk fruit and movement by motor truck alone.

The markets chosen, in the order of volume of receipts from the 31 citrus packinghouses, were: New York, Chicago, Detroit, Cincinnati, Pittsburgh, Minneapolis, Kansas City, and New Orleans. The last three markets, however, received only very small quantities of fruit. Because of its importance as a citrus market, New York City has been compared with all the other markets as a group.

To facilitate sorting and tabulating, the data on the individual car-shipment manifests were transferred to punch cards. Two types of these cards were used, one of which was designed to carry the price information, and the other the charges against the fruit incident to getting it from the packinghouse to the market, including selling. A copy of each of these punch cards is shown in the appendix.

Acknowledgments: The writers wish to express their thanks to all who have assisted in the preparation of this work. Special credit is due Dr. C. V. Noble, under whose direction the study was made, and Dr. H. G. Hamilton who assisted in outlining the work and offered helpful criticism. Appreciation is also due Mr. Zach Savage for his aid.

The Farm Credit Administration cooperated in the completion by furnishing the use of Hollerith electric sorting and tabulating equipment, and operators, at Columbia, South Carolina.

Records from which data were taken were kindly made available by the Florida Citrus Exchange, Tampa, and the Florida Division of the American Fruit Growers, Inc., Orlando.

*Chief Statistician, Farm Credit Administration, Columbia, South Carolina.

The following adjustments were made with respect to containers and sizes. Unless otherwise stated, oranges and grapefruit were converted to full boxes, and Temple oranges and tangerines to half-boxes, if they were shipped in containers other than these. The conversion factor used was the same as used by the packinghouse shipping the fruit. The container most frequently used other than the standard box was the bushel basket, especially for Temples and tangerines, and in most cases one full box was found to be equivalent to 1.6 bushel baskets.

Orange sizes larger than 100, grapefruit sizes larger than 36, and sizes for Temples and tangerines larger than 90 were placed in one size group termed "other sizes".

Before the price data were placed on punch cards, the price for each size of fruit was multiplied by the number of boxes in that size and the value punched to the nearest even dollar.

Because of the small amount of fruit moving at the beginning and at the end of the season, September and October have been combined; also July and August.

AUCTION SALES OF FLORIDA CITRUS FRUIT

TOTAL SALES OF ALL VARIETIES

A summary of total shipments of citrus on which this study is based is shown in Table 1. Only fruit which sold at auction is included here.

"Other varieties" of oranges and of grapefruit include fruit which was unmarked as to variety, and a few varieties not of sufficient volume to warrant separation. For the three seasons oranges made up about one-half the total sales, with grapefruit and mandarin oranges about 40 percent and 10 percent, respectively. Valencia oranges comprised about one-fifth of the total, and were larger in volume than any other variety of oranges. Parson Browns constituted only a very small percentage of the oranges.

New York City was more important than all the other markets combined from the standpoint of receipts from the 31 packinghouses (Fig. 2).

MONTHLY AVERAGE ORANGE PRICES

The monthly average price received for Florida oranges by variety and grade on the terminal auctions is shown in Table 2. In the grade comparisons, grade 1 and grade 2 are equivalent in most cases to the U. S. standard grades, and supergrade

TABLE 1.—SUMMARY OF TOTAL AUCTION SALES OF CITRUS FRUIT FROM 31 FLORIDA PACKINGHOUSES TO FIVE MARKETS.

Variety of fruit	Season						Total	
	1930-31		1931-32		1932-33			
	Number of boxes	Percent of all varieties	Number of boxes	Percent of all varieties	Number of boxes	Percent of all varieties	Number of boxes	Percent of all varieties
Oranges:								
Parson Brown	27,190	1.8	5,653	.5	5,937	.5	38,780	1.0
Pineapple	177,215	11.4	131,955	11.4	177,722	15.0	486,892	12.4
Valencia	315,801	20.3	250,374	21.5	260,739	21.9	826,914	21.2
Other varieties	235,512	15.2	152,801	13.1	200,503	16.9	588,816	15.1
Total oranges	755,718	48.7	540,783	46.5	644,901	54.3	1,941,402	49.7
Grapefruit:								
Marsh Seedless	173,101	11.1	142,425	12.2	138,488	11.6	454,014	11.6
Other varieties	487,400	31.4	339,190	29.2	304,944	25.7	1,131,534	29.0
Total grapefruit	660,501	42.5	481,615	41.4	443,432	37.3	1,585,548	40.6
Mandarins:[1]								
King	1,977.5	.1	2,864.0	.2	1,205.5	.1	6,047.0	.2
Temple	4,907.5	.3	7,689.5	.7	10,322.0	.9	22,919.0	.6
Tangerines	128,768.5	8.3	130,815.0	11.2	87,507.5	7.4	347,091.0	8.9
Satsumas	943.0	.1	154.5	*	142.0	*	1,239.5	*
Total mandarins	136,596.5	8.8	141,523	12.1	99,177	8.4	377,296.5	9.7
All varieties	1,552,815.5	100.0	1,163,921	100.0	1,187,510	100.0	3,904,246.5	100.0

*Less than one-tenth of 1 percent.

[1] Converted to full boxes.

TABLE 2.—FLORIDA ORANGES—MONTHLY AVERAGE AUCTION PRICES PER BOX, ALL SIZES, IN FIVE MARKETS, BY VARIETY AND GRADE.

Month Sold	Parson Brown																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
									1930-31									
September-October							7,156	$4.95			7,156	$4.95	542	$4.80	360	$4.41	902	$4.65
November							10,260	3.58	1,732	$3.70	11,992	3.60	1,334	3.00	4,772	2.74	6,106	2.80
December							136	2.85			136	2.85			898	2.26	898	2.26
Total or average							17,552	$4.13	1,732	$3.70	19,284	$4.09	1,876	$3.52	6,030	$2.77	7,906	$2.95
									1931-32									
September-October									40	$2.30	40	$2.30			97	$1.64	97	$1.64
November							2,169	$3.19	188	2.93	2,357	3.17	898	$2.55	431	2.40	1,329	2.50
December	289	$3.48			289	$3.48	843	3.00			843	3.00	682	3.18			682	3.18
January	6	3.83			6	3.83	10	3.20			10	3.20						
Total or average	295	$3.49			295	$3.49	3,022	$3.14	228	$2.82	3,250	$3.11	1,580	$2.82	528	$2.26	2,108	$2.68
									1932-33									
September-October							81	$2.88			81	$2.88	66	$2.41			66	$2.41
November	23	$3.39			23	$3.39	2,942	3.43			2,942	3.43	1,092	2.81	542	$3.51	1,634	3.04
December							331	3.42			331	3.42			346	3.23	346	3.23
January																		
February													105	1.85			105	1.85
Total or average	23	$3.39			23	$3.39	3,354	$3.42			3,354	$3.42	1,263	$2.71	888	$3.40	2,151	$2.99

TABLE 2.—FLORIDA ORANGES—MONTHLY AVERAGE AUCTION PRICES PER BOX, ALL SIZES, IN FIVE MARKETS, BY VARIETY AND GRADE *(Continued)*.

Month Sold	Pineapple																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
1930-31																		
September-October	390	$5.72			390	$5.72	257	$4.16			257	$4.16	157	$4.54			157	$4.54
November	5,100	4.86	22	$4.68	5,122	4.86	6,817	3.83	3,431	$3.51	10,248	3.72	857	3.20	4,183	$2.88	5,040	2.93
December	5,860	4.10	41	3.85	5,901	4.10	14,570	3.48	5,798	3.32	20,368	3.44	2,482	3.17	6,066	2.68	8,548	2.82
January	6,386	3.84	13	4.00	6,399	3.84	22,984	3.29	5,920	3.10	28,904	3.25	4,352	2.92	5,739	2.68	10,091	2.79
February	4,824	3.88	561	3.36	5,385	3.83	18,008	3.50	7,010	3.17	25,018	3.41	8,197	3.05	6,618	2.93	14,815	2.99
March	4,799	4.48	174	4.06	4,973	4.46	13,447	4.06	4,573	3.90	18,020	4.02	4,025	3.67	1,548	3.53	5,573	3.63
April	514	4.32	55	3.75	569	4.26	1,053	3.92	249	3.30	1,302	3.80			26	3.58	26	3.58
May							10	3.40			10	3.40	12	3.42			12	3.42
Total or average	27,873	$4.23	866	$3.59	28,739	$4.21	77,146	$3.57	26,981	$3.35	104,127	$3.51	20,082	$3.18	24,180	$2.84	44,262	$2.99
1931-32																		
November	600	$3.53	1	$3.00	601	$3.53	2,028	$3.72	1,688	$3.47	3,716	$3.61	946	$3.14	819	$2.79	1,765	$2.98
December	2,623	4.04	233	3.29	2,856	3.98	13,428	3.58	3,519	3.17	16,947	3.50	4,593	2.94	2,166	2.82	6,759	2.90
January	4,894	3.71	103	4.09	4,997	3.71	21,690	3.43	5,568	3.21	27,258	3.39	7,046	3.12	5,246	2.81	12,292	2.99
February	1,680	4.10	166	3.83	1,846	4.07	21,405	3.70	5,192	3.50	26,597	3.66	7,752	3.39	6,408	3.27	14,160	3.33
March	388	4.89			388	4.89	6,196	3.95			6,196	3.95	2,647	3.28	1,332	3.62	3,979	3.39
April	456	4.36			456	4.36	75	3.89			75	3.89	60	3.30	3	3.33	63	3.30
May							60	4.42			60	4.42	319	3.88			319	3.88
Total or average	10,641	$3.91	503	$3.63	11,144	$3.90	64,882	$3.61	15,967	$3.32	80,849	$3.55	23,363	$3.20	15,974	$3.06	39,337	$3.15
1932-33																		
November	111	$4.42			111	$4.42	2,497	$3.81	23	$3.09	2,520	$3.80	567	$2.99	1,356	$3.22	1,923	$3.15
December	4,077	3.71	95	$3.15	4,172	3.70	21,586	3.14	7,150	2.91	28,736	3.09	5,166	2.67	7,037	2.75	12,203	2.72
January	3,321	3.77	180	3.41	3,501	3.75	22,452	3.18	3,619	3.13	26,071	3.17	4,480	2.43	7,454	2.87	11,934	2.71
February	2,208	3.42	233	3.14	2,441	3.40	18,612	2.84	2,853	2.82	21,465	2.84	7,921	2.18	6,876	2.65	14,797	2.40
March	2,550	3.76	279	3.04	2,829	3.69	14,584	2.87	2,762	2.74	17,346	2.85	10,598	2.26	5,726	2.49	16,324	2.34
April	524	3.47			524	3.47	4,568	2.55	919	2.74	5,487	2.58	1,311	1.97	1,508	2.10	2,819	2.04
May	19	2.32			19	2.32	1,348	2.09			1,348	2.09	325	1.94			325	1.94
Total or average	12,810	$3.68	787	$3.17	13,597	$3.65	85,647	$3.01	17,326	$2.91	102,973	$3.00	30,368	$2.33	29,957	$2.70	60,325	$2.51

TABLE 2.—FLORIDA ORANGES—MONTHLY AVERAGE AUCTION PRICES PER BOX, ALL SIZES, IN FIVE MARKETS, BY VARIETY AND GRADE *(Continued)*.

Month Sold	Valencia																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
									1930-31									
February							839	$3.87			839	$3.87	931	$2.94			931	$2.94
March	2,666	$4.08	13	$4.08	2,679	$4.08	24,735	3.76	8,539	$3.72	33,274	3.75	2,515	3.35	4,818	$3.38	7,333	3.37
April	1,708	4.27	29	3.97	1,737	4.26	31,905	3.97	10,224	3.77	42,129	3.92	9,161	3.68	11,834	3.66	20,995	3.67
May	7,209	4.35	725	4.04	7,934	4.32	51,850	3.95	24,552	3.85	76,402	3.92	16,076	3.69	27,003	3.63	43,079	3.65
June	508	5.06			508	5.06	30,223	4.36	12,735	4.01	42,958	4.26	14,964	3.78	14,205	3.56	29,169	3.67
July-August							1,717	4.23			1,717	4.23	1,627	3.75	180	3.26	1,807	3.70
Total or average	12,091	$4.31	767	$4.04	12,858	$4.29	141,269	$4.01	56,050	$3.85	197,319	$3.97	45,274	$3.69	58,040	$3.60	103,314	$3.64
									1931-32									
February	283	$4.82			283	$4.82	329	$3.50			329	$3.50						
March	4,549	4.38	71	$4.48	4,620	4.38	33,100	3.99	6,694	$3.63	39,794	3.93	6,011	$3.54	8,357	$3.76	14,368	$3.67
April	4,966	4.63	32	5.31	4,998	4.63	33,278	3.93	8,396	3.91	41,674	3.92	7,748	3.55	15,240	3.82	22,988	3.73
May	111	4.62			111	4.62	41,214	3.80	10,518	3.71	51,732	3.78	15,852	3.35	15,128	3.52	30,980	3.44
June							21,914	3.72	963	3.73	22,877	3.72	12,123	3.37	872	3.65	12,995	3.39
Total or average	9,909	$4.52	103	$4.74	10,012	$4.52	129,835	$3.87	26,571	$3.75	156,406	$3.85	41,734	$3.42	39,597	$3.69	81,331	$3.55
									1932-33									
March	235	$3.50	30	$3.27	265	$3.47	5,942	$2.71	338	$2.82	6,280	$2.71	4,072	$2.24	1,446	$2.33	5,518	$2.26
April	1,503	3.58			1,503	3.58	22,364	2.70	3,715	2.64	26,079	2.69	15,053	2.16	22,352	2.38	37,405	2.29
May	3,389	3.21	575	2.82	3,964	3.15	31,945	2.42	6,593	2.52	38,538	2.44	31,022	2.00	42,110	2.22	73,132	2.12
June	581	3.83	227	3.33	808	3.69	10,436	2.77	1,627	3.08	12,063	2.82	29,978	2.21	10,715	2.54	40,693	2.30
July-August							1,168	2.87	37	3.38	1,205	2.88	6,250	2.73	724	3.02	6,974	2.76
Total or average	5,708	$3.38	832	$2.97	6,540	$3.33	71,855	$2.59	12,310	$2.64	84,165	$2.60	86,375	$2.17	77,347	$2.32	163,722	$2.24

TABLE 2.—FLORIDA ORANGES—MONTHLY AVERAGE AUCTION PRICES PER BOX, ALL SIZES, IN FIVE MARKETS, BY VARIETY AND GRADE *(Concluded)*.

Month Sold	Other Varieties																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
									1930-31									
September October							4,508	$4.93	2,539	$4.43	7,047	$4.75	1,096	$3.61	1,981	$3.40	3,077	$3.47
November	1,260	$3.89	38	$4.92	1,298	$3.92	22,024	3.71	10,606	2.89	32,630	3.44	4,403	2.77	6,781	2.47	11,184	2.58
December	1,159	3.55	352	3.64	1,511	3.57	20,384	3.04	6,309	2.85	26,693	3.00	4,798	2.71	7,974	2.37	12,772	2.50
January	3,084	3.12	87	3.90	3,171	3.15	20,606	3.00	5,726	2.73	26,332	2.94	7,282	2.64	8,063	2.46	15,345	2.54
February	5,605	3.41	255	3.05	5,860	3.39	19,341	3.18	7,752	2.99	27,093	3.12	3,726	3.04	7,271	2.82	10,997	2.89
March	3,619	4.00			3,619	4.00	16,039	3.81	1,268	3.77	17,307	3.81	3,702	3.44	1,881	3.65	5,583	3.51
April	981	3.87	3	4.00	984	3.87	7,903	3.72	1,548	4.11	9,451	3.78	785	3.54	860	3.53	1,645	3.54
May	2,121	4.20			2,121	4.20	2,909	3.88	1,110	4.17	4,019	3.96	940	3.17	529	3.93	1,469	3.44
June							2,082	4.25			2,082	4.25	487	3.37	360	2.98	847	3.20
July-August							360	4.28			360	4.28						
Total or average	17,829	$3.64	735	$3.54	18,564	$3.64	116,156	$3.46	36,858	$3.11	153,014	$3.37	27,219	$2.93	35,700	$2.68	62,919	$2.79
									1931 32									
September-October									744	$2.90	744	$2.90			30	$1.33	30	$1.33
November	187	$4.57			187	$4.57	9,300	$3.48	3,700	3.02	13,000	3.35	1,862	$2.77	2,075	2.50	3,937	2.63
December	1,675	3.70	145	$3.23	1,820	3.66	15,956	3.25	4,862	2.96	20,818	3.18	7,566	2.83	3,273	2.63	10,839	2.77
January	1,055	3.42	114	3.79	1,169	3.45	17,163	3.08	2,215	3.03	19,378	3.07	6,833	2.66	4,656	2.58	11,489	2.63
February	1,042	3.85	79	3.39	1,121	3.82	19,750	3.42	4,027	3.09	23,777	3.36	8,973	3.17	4,869	3.05	13,842	3.13
March	819	4.43	16	4.31	835	4.43	7,611	3.52	2,916	3.53	10,527	3.52	5,077	3.17	2,212	3.25	7,289	3.19
April	368	4.32			368	4.32	2,637	3.85	1,120	3.78	3,757	3.83	1,076	3.38	1,117	3.79	2,193	3.59
May							1,495	3.72	816	4.18	2,311	3.88	299	3.32	822	3.49	1,121	3.45
June							672	3.52			672	3.52	473	3.56			473	3.56
July-August																		
Total or average	5,146	$3.86	354	$3.50	5,500	$3.84	74,584	$3.34	20,400	$3.18	94,984	$3.31	32,159	$2.97	19,054	$2.89	51,213	$2.94
									1932-33									
September-October									63	$3.76	63	$3.76						
November	281	$3.63	37	$3.70	318	$3.64	7,767	$3.52	2,991	3.19	10,758	3.43	2,261	$2.85	2,067	$2.78	4,328	$2.81
December	256	2.75	97	3.40	353	2.93	18,659	2.82	2,353	2.74	21,012	2.81	5,605	2.38	2,470	2.72	8,075	2.49
January	317	3.25			317	3.25	14,211	2.77	3,710	2.82	17,921	2.78	8,097	2.40	3,953	2.62	12,050	2.47
February	285	3.39	81	3.46	366	3.40	13,410	2.41	3,630	2.82	17,040	2.50	12,471	1.94	6,494	2.49	18,965	2.13
March	206	3.15	203	3.17	409	3.16	17,699	2.37	2,182	2.73	19,881	2.41	21,765	2.06	4,844	2.47	26,609	2.13
April	113	2.70	29	3.17	142	2.80	12,556	2.05	2,521	2.36	15,077	2.10	13,013	1.79	2,235	2.19	15,248	1.85
May	340	3.44			340	3.44	2,286	2.33	5	2.00	2,291	2.33	2,585	1.81	1,171	2.02	3,756	1.88
June	94	3.95			94	3.95	972	2.96			972	2.96	2,605	2.37			2,605	2.37
July-August													118	2.61			118	2.61
Total or average	1,892	$3.28	447	$3.32	2,339	$3.29	87,560	$2.60	17,455	$2.80	105,015	$2.63	68,520	$2.08	23,234	$2.51	91,754	$2.19

TABLE 3.—FLORIDA ORANGES—MONTHLY AVERAGE AUCTION PRICES PER BOX, ALL SIZES, IN FIVE MARKETS, BY VARIETY, ALL GRADES COMBINED.[1]

Month Sold	Parson Brown						Pineapple						Valencia					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
1930-31																		
September-October	7,698	$4.94	360	$4.41	8,058	$4.91	875	$4.87			875	$4.87						
November	11,594	3.52	6,504	2.99	18,098	3.33	12,784	4.19	7,636	$3.17	20,420	3.81						
December	136	2.85	898	2.26	1,034	2.34	22,912	3.61	11,905	2.99	34,817	3.40						
January							33,722	3.35	11,672	2.89	45,394	3.23						
February							31,029	3.44	14,189	3.06	45,218	3.32	1,770	$3.38			1,770	$3.38
March							22,271	4.08	6,295	3.81	28,566	4.02	29,934	3.75	13,370	$3.60	43,304	3.71
April							1,567	4.05	330	3.40	1,897	3.94	42,774	3.92	22,087	3.71	64,861	3.85
May							28	3.32			28	3.32	75,189	3.93	53,701	3.73	128,890	3.85
June													45,761	4.18	27,276	3.76	73,037	4.02
July-August													3,759	3.95	180	3.26	3,939	3.92
Total or average	19,428	$4.07	7,762	$2.97	27,190	$3.76	125,188	$3.65	52,027	$3.12	177,215	$3.50	199,187	$3.95	116,614	$3.72	315,801	$3.87
1931-32																		
September-October			137	$1.83	137	$1.83	3,574	$3.54	2,508	$3.25	6,082	$3.42						
November	3,067	$3.00	619	2.56	3,686	2.93	20,644	3.50	5,918	3.04	26,562	3.40						
December	1,814	3.15			1,814	3.15	33,630	3.41	11,048	3.02	44,678	3.31						
January	16	3.44			16	3.44	30,837	3.64	12,260	3.37	43,097	3.57	612	$4.11			612	$4.11
February							9,231	3.80	1,332	3.62	10,563	3.78	43,732	3.96	15,470	$3.70	59,202	3.89
March							591	4.19	3	3.33	594	4.19	46,338	3.93	24,051	3.84	70,389	3.90
April							379	3.97			379	3.97	57,347	3.68	26,569	3.59	83,916	3.65
May													34,137	3.59	2,118	3.62	36,255	3.59
June																		
Total or average	4,897	$3.06	756	$2.43	5,653	$2.97	98,886	$3.55	33,069	$3.20	131,955	$3.46	182,166	$3.80	68,208	$3.70	250,374	$3.77
1932-33																		
September-October	147	$2.67			147	$2.67												
November	4,466	3.19	542	$3.51	5,008	3.22	3,175	$3.68	1,379	$3.22	4,554	$3.54						
December	331	3.42	346	3.23	677	3.33	30,829	3.14	14,333	2.84	45,162	3.04						
January							30,373	3.13	11,253	2.96	41,626	3.08						
February	105	1.85			105	1.85	28,791	2.70	9,997	2.71	38,788	2.71						
March							28,259	2.71	8,811	2.58	37,070	2.68	10,792	$2.52	1,814	$2.44	12,606	$2.51
April							6,403	2.51	2,427	2.34	8,830	2.46	39,863	2.51	26,579	2.40	66,442	2.47
May							1,692	2.07			1,692	2.07	67,983	2.25	49,278	2.27	117,261	2.26
June													42,804	2.35	12,706	2.63	55,510	2.42
July-August													8,159	2.72	761	3.03	8,920	2.75
Total or average	5,049	$3.16	888	$3.40	5,937	$3.20	129,522	$2.92	48,200	$2.78	177,722	$2.88	169,601	$2.38	91,138	$2.37	260,739	$2.37

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[1] Includes a small amount of Grade 3 fruit.

TABLE 3.—FLORIDA ORANGES—MONTHLY AVERAGE AUCTION PRICES PER BOX, ALL SIZES, IN FIVE MARKETS, BY VARIETY, ALL GRADES COMBINED[1]—*(Concluded)*.

Month Sold	Other Varieties						All Varieties					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
1930-31												
September-October	5,632	$4.66	4,584	$3.95	10,216	$4.35	14,205	$4.82	4,944	$3.99	19,149	$4.61
November	27,687	3.57	17,895	2.72	45,582	3.24	52,065	3.71	32,035	2.88	84,100	3.39
December	26,437	3.00	14,675	2.61	41,112	2.86	49,485	3.28	27,478	2.76	76,963	3.10
January	30,972	2.93	13,876	2.58	44,848	2.82	64,694	3.15	25,548	2.72	90,242	3.03
February	28,672	3.20	15,278	2.91	43,950	3.10	61,471	3.33	29,467	2.98	90,938	3.22
March	23,360	3.78	3,466	3.49	26,826	3.75	75,565	3.86	23,131	3.64	98,696	3.81
April	9,669	3.72	2,411	3.90	12,080	3.76	54,010	3.89	24,828	3.73	78,838	3.84
May	5,970	3.88	1,639	4.09	7,609	3.93	81,187	3.93	55,340	3.74	136,527	3.85
June	2,569	4.08	360	2.98	2,929	3.95	48,330	4.17	27,636	3.75	75,966	4.02
July-August	360	4.28			360	4.28	4,119	3.98	180	3.26	4,299	3.95
Total or average	161,328	$3.39	74,184	$2.89	235,512	$3.23	505,131	$3.70	250,587	$3.33	755,718	$3.58
1931-32												
September-October			799	$2.77	799	$2.77			936	$2.64	936	$2.64
November	11,349	$3.38	5,775	2.83	17,124	3.20	17,990	$3.35	8,902	2.93	26,892	3.21
December	25,197	3.15	8,280	2.83	33,477	3.07	47,655	3.30	14,198	2.92	61,853	3.21
January	25,051	2.98	7,108	2.73	32,159	2.92	58,697	3.22	18,156	2.91	76,853	3.15
February	29,948	3.36	8,975	3.07	38,923	3.29	61,397	3.51	21,235	3.25	82,632	3.44
March	13,745	3.43	5,144	3.41	18,889	3.43	66,708	3.83	21,946	3.62	88,654	3.78
April	4,081	3.77	2,237	3.79	6,318	3.77	51,010	3.92	26,291	3.84	77,301	3.89
May	1,794	3.65	1,789	3.78	3,583	3.72	59,520	3.68	28,358	3.60	87,878	3.65
June	1,145	3.54	384	2.24	1,529	3.21	35,282	3.59	2,502	3.40	37,784	3.58
Total or average	112,310	$3.26	40,491	$3.03	152,801	$3.20	398,259	$3.57	142,524	$3.39	540,783	$3.52
1932-33												
September-October			63	$3.76	63	$3.76	147	$2.67	63	$3.76	210	$3.00
November	10,309	$3.38	5,095	3.02	15,404	3.26	17,950	3.38	7,016	3.10	24,966	3.30
December	24,678	2.72	4,927	2.75	29,605	2.72	55,838	2.95	19,606	2.82	75,444	2.92
January	22,654	2.64	7,956	2.70	30,610	2.66	53,027	2.92	19,209	2.85	72,236	2.90
February	26,166	2.20	10,205	2.62	36,371	2.32	55,062	2.46	20,202	2.66	75,264	2.52
March	40,072	2.20	7,556	2.54	47,628	2.25	79,123	2.42	18,181	2.55	97,304	2.45
April	25,756	1.92	4,833	2.28	30,589	1.98	72,022	2.30	33,839	2.38	105,861	2.33
May	5,211	2.15	1,176	2.02	6,387	2.12	74,886	2.24	50,454	2.26	125,340	2.25
June	3,728	2.56			3,728	2.56	46,532	2.37	12,706	2.63	59,238	2.42
July-August	118	2.61			118	2.61	8,277	2.72	761	3.03	9,038	2.75
Total or average	158,692	$2.38	41,811	$2.63	200,503	$2.43	462,864	$2.54	182,037	$2.54	644,901	$2.54

[1] Includes a small amount of Grade 3 fruit.

refers to a grade above U. S. No. 1 minimum requirements. Each price was obtained by dividing the total value of the fruit sold by the number of boxes in the particular lot.

The price per box was usually somewhat higher on the New York auction than the average of all the other auctions when the same grades and varieties were compared. However, there were exceptions to this, notably during the 1932-33 season when the reverse was frequently true.

The monthly average auction price received for Florida oranges by variety with all grades combined is shown in Table 3, and the average seasonal distribution of varieties in Fig. 3. The variety prices contain third grade fruit in addition to super-grade, grade 1, and grade 2. This third grade fruit has the effect of lowering the variety price slightly in most cases, but is usually too small in volume to be of significance.

For price comparisons between New York and "Other Markets", Table 2 should be used rather than Table 3, since New York received a higher proportion of high grade fruit than did the "Other Markets".

The price received for a variety may depend more upon the season of the year in which it moved than upon the characteristics or qualities of the variety itself. In 1931-32 oranges which sold in the latter part of the season brought the better average price, whereas in 1932-33 the reverse was true (Fig. 4).

Pineapple oranges seem to have been the preferred variety on the auctions, though during the peak of their season there was usually little opportunity to compare them with an adequate sample of other individual varieties. The heaviest month of Parson Brown movement comes during the beginning of the Pineapple season, and the Valencia season does not usually begin until the movement of Pineapple oranges is declining rapidly (Figs. 5, 6, and 7). The three-season weighted average price by varieties is highest for Parson Brown, which brought $3.56 per box, compared with an average of $3.37 for Valencia, $3.26 per box for Pineapple, and $2.95 per box for "Other Varieties".

A five-year average monthly price of all Florida oranges sold on the five auctions for the seasons 1931-32 to 1935-36, inclusive, was lower than the prices for the 1930-31 and for the 1931-32 seasons as found in this study. It was also lower than the first part of the 1932-33 season, but higher than the latter part. This five-year average, however, covers a period when citrus prices and returns were frequently unsatisfactory (Fig. 4).

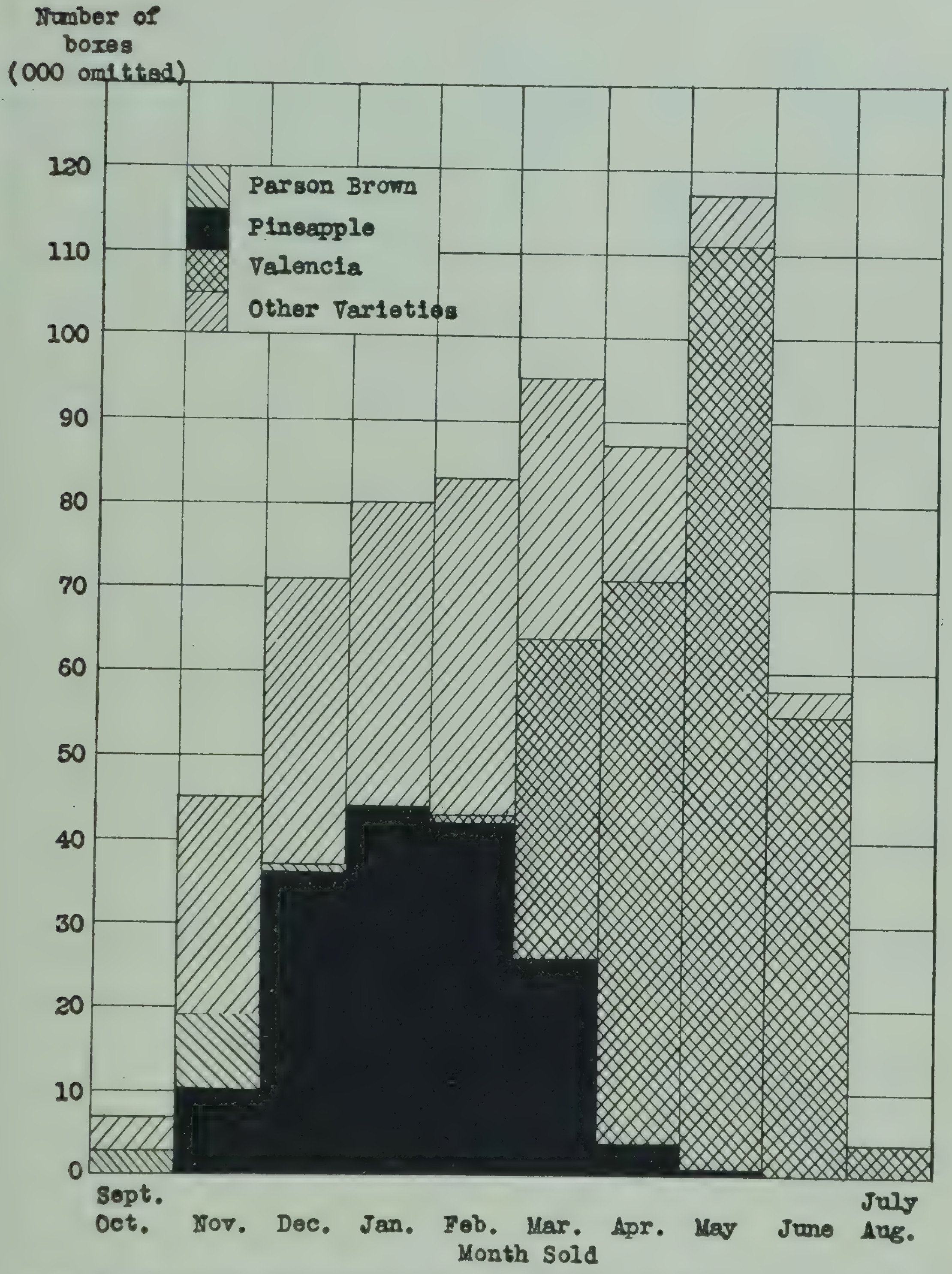

Fig. 3.—Seasonal distribution of auction sales of Florida oranges from 31 packinghouses to five markets (average of three seasons, 1930-31, 1931-32, and 1932-33).

In Table 4 is shown the monthly average auction price of Florida oranges by grade, irrespective of variety. It should be remembered, however, that the prices in the first months of the season are for Parson Brown, Pineapple, and "Other Varieties"; that in midseason they are Pineapple and "Other Varieties"; and that in the latter part of the season they are predominantly Valencia (Fig. 3). The price of supergrade was consistently above the price of grade 1 oranges, averaging for the three seasons 54 cents per box higher; and the price of grade 1 oranges exceeded the price of grade 2 oranges by an average of 42 cents per box for the three seasons (Figs. 8, 9, and 10). The greatest differences occurred in 1932-33 when there was a smaller proportion of supergrade and grade 1 fruit than in the preceding two seasons.

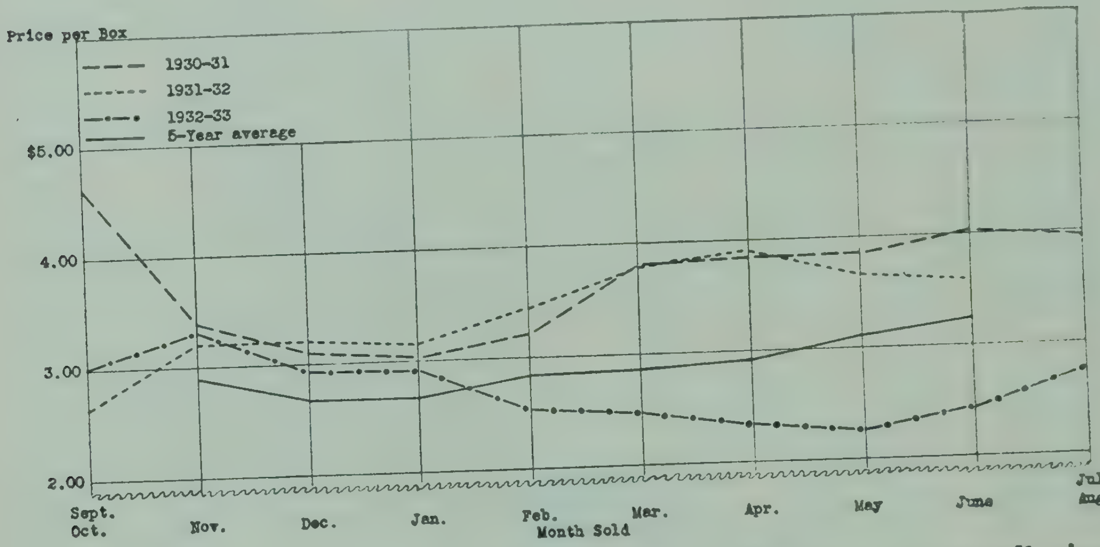

Fig. 4.—Monthly average auction prices of Florida oranges, all sizes, from 31 packinghouses to five markets, by seasons, compared with a five-year average, 1931-32 to 1935-36, inclusive, of the total sales of Florida oranges in the same markets.

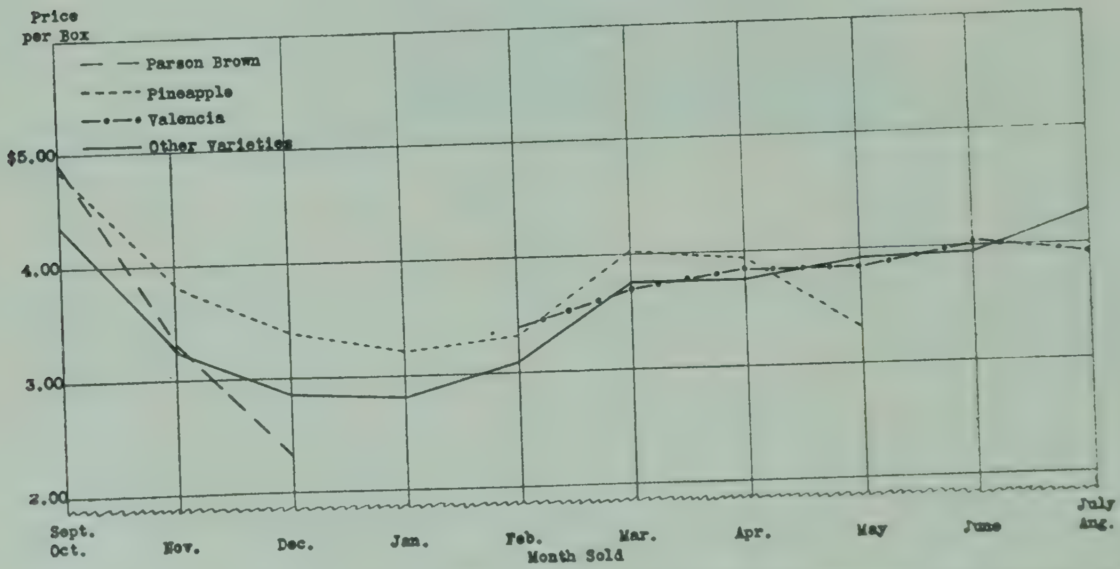

Fig. 5.—Monthly average auction prices of Florida oranges, all sizes, by variety, five markets, 1930-31.

TABLE 4.—FLORIDA ORANGES—MONTHLY AVERAGE AUCTION PRICES PER BOX, ALL SIZES, IN FIVE MARKETS, BY GRADE, ALL VARIETIES COMBINED.

Month Sold	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
									1930-31									
September-October	390	$5.72			390	$5.72	11,921	$4.92	2,539	$4.43	14,460	$4.84	1,795	$4.05	2,341	$3.55	4,136	$3.77
November	6,360	4.67	60	$4.83	6,420	4.67	39,101	3.70	15,769	3.11	54,870	3.53	6,594	2.87	15,736	2.66	22,330	2.72
December	7,019	4.01	393	3.66	7,412	3.99	35,090	3.22	12,107	3.08	47,197	3.19	7,280	2.87	14,938	2.49	22,218	2.61
January	9,470	3.60	100	3.91	9,570	3.61	43,590	3.15	11,646	2.92	55,236	3.10	11,634	2.75	13,802	2.55	25,436	2.64
February	10,429	3.63	816	3.27	11,245	3.60	38,188	3.34	14,762	3.07	52,950	3.27	12,854	3.04	13,889	2.87	26,743	2.95
March	11,084	4.23	187	4.06	11,271	4.22	54,221	3.85	14,380	3.78	68,601	3.83	10,242	3.51	8,247	3.47	18,489	3.49
April	3,203	4.15	87	3.83	3,290	4.14	40,861	3.92	12,021	3.81	52,882	3.89	9,946	3.67	12,720	3.65	22,666	3.66
May	9,330	4.32	725	4.04	10,055	4.30	54,769	3.95	25,662	3.87	80,431	3.92	17,028	3.66	27,532	3.64	44,560	3.65
June	508	5.06			508	5.06	32,305	4.36	12,735	4.01	45,040	4.26	15,451	3.77	14,565	3.55	30,016	3.66
July-August							2,077	4.24			2,077	4.24	1,627	3.75	180	3.26	1,807	3.70
Total or average	57,793	$4.07	2,368	$3.72	60,161	$4.05	352,123	$3.74	121,621	$3.51	473,744	$3.68	94,451	$3.36	123,950	$3.15	218,401	$3.24
									1931-32									
September-October									784	$2.86	784	$2.86			127	$1.57	127	$1.57
November	787	$3.78	1	$3.00	788	$3.78	13,497	$3.47	5,576	3.15	19,073	3.38	3,706	$2.81	3,325	2.56	7,031	2.69
December	4,587	3.88	378	3.27	4,965	3.83	30,227	3.39	8,381	3.04	38,608	3.32	12,841	2.89	5,439	2.71	18,280	2.83
January	5,955	3.65	217	3.93	6,172	3.66	38,863	3.28	7,783	3.16	46,646	3.26	13,879	2.89	9,902	2.70	23,781	2.81
February	3,005	4.08	245	3.69	3,250	4.05	41,484	3.56	9,219	3.32	50,703	3.52	16,725	3.27	11,277	3.17	28,002	3.23
March	5,756	4.42	87	4.45	5,843	4.42	46,907	3.91	9,610	3.60	56,517	3.85	13,735	3.35	11,901	3.65	25,636	3.49
April	5,790	4.59	32	5.31	5,822	4.59	35,990	3.92	9,516	3.89	45,506	3.91	8,884	3.53	16,360	3.82	25,244	3.72
May	111	4.62			111	4.62	42,769	3.80	11,334	3.74	54,103	3.79	16,470	3.36	15,950	3.52	32,420	3.44
June							22,586	3.71	963	3.73	23,549	3.71	12,596	3.38	872	3.65	13,468	3.39
Total or average	25,991	$4.13	960	$3.70	26,951	$4.11	272,323	$3.65	63,166	$3.45	335,489	$3.62	98,836	$3.21	75,153	$3.34	173,989	$3.27
									1932-33									
September-October							81	$2.88	63	$3.76	144	$3.26	66	$2.41			66	$2.41
November	415	$3.83	37	$3.70	452	$3.82	13,206	3.56	3,014	3.19	16,220	3.49	3,920	2.86	3,965	$3.03	7,885	2.94
December	4,333	3.66	192	3.28	4,525	3.64	40,576	3.00	9,503	2.87	50,079	2.97	10,771	2.52	9,853	2.76	20,624	2.64
January	3,638	3.72	180	3.41	3,818	3.71	36,663	3.02	7,329	2.97	43,992	3.01	12,577	2.41	11,407	2.78	23,984	2.59
February	2,493	3.42	314	3.22	2,807	3.40	32,022	2.66	6,483	2.82	38,505	2.69	20,497	2.03	13,370	2.57	33,867	2.25
March	2,991	3.70	512	3.11	3,503	3.61	38,225	2.61	5,282	2.74	43,507	2.63	36,435	2.14	12,016	2.46	48,451	2.22
April	2,140	3.50	29	3.17	2,169	3.50	39,488	2.47	7,155	2.55	46,643	2.49	29,377	1.99	26,095	2.35	55,472	2.16
May	3,748	3.23	575	2.82	4,323	3.17	35,579	2.41	6,598	2.52	42,177	2.42	33,932	1.98	43,281	2.21	77,213	2.11
June	675	3.84	227	3.33	902	3.72	11,408	2.79	1,627	3.08	13,035	2.83	32,583	2.23	10,715	2.54	43,298	2.30
July-August							1,168	2.87	37	3.38	1,205	2.88	6,368	2.73	724	3.02	7,092	2.76
Total or average	20,433	$3.56	2,066	$3.12	22,499	$3.52	248,416	$2.75	47,091	$2.80	295,507	$2.76	186,526	$2.17	131,426	$2.45	317,952	$2.28

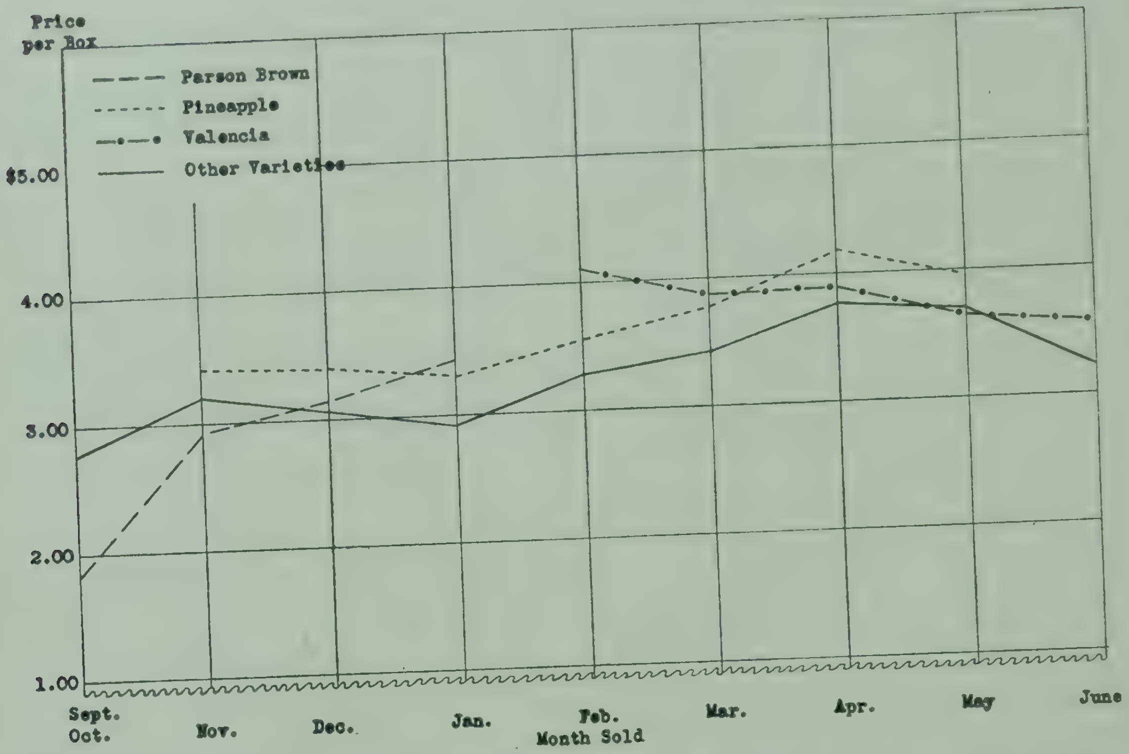

Fig. 6.—Monthly average auction prices of Florida oranges, all sizes, by variety, in five markets, 1931-32.

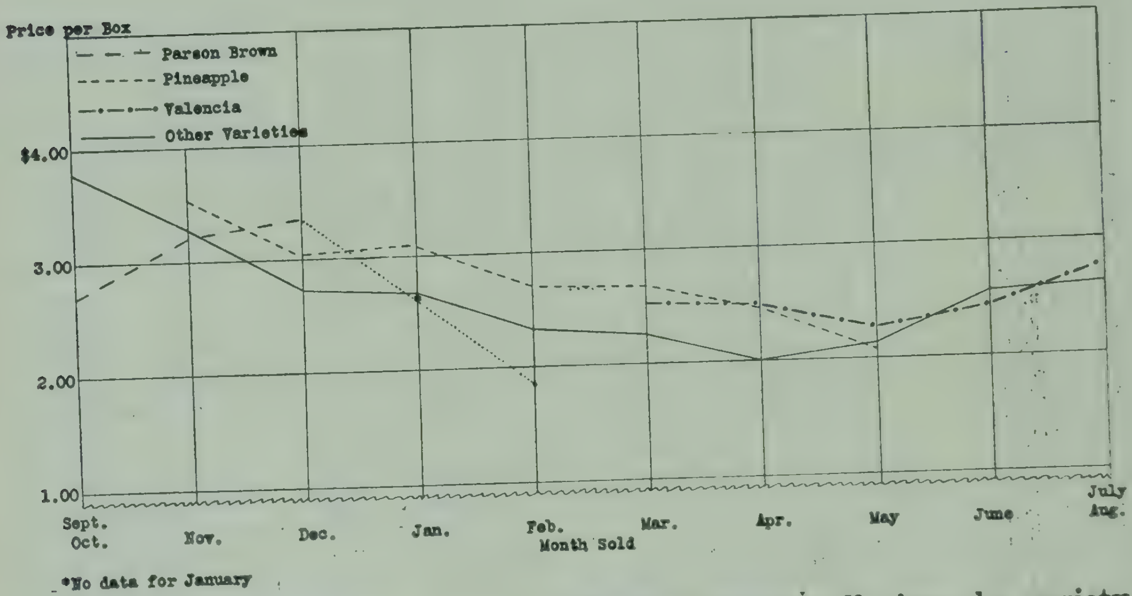

Fig. 7.—Monthly average prices of Florida oranges, all sizes, by variety, in five markets, 1932-33.

MONTHLY AVERAGE GRAPEFRUIT PRICES

The monthly average price received for grapefruit on the auctions showed a generally downward trend in 1930-31 and 1932-33. In 1931-32 the average price received each month declined to about the middle of the season and then turned upward. Each of the three seasons as found in this study was above a five-year monthly average price of all Florida grapefruit sold on the five auctions 1931-32 to 1935-36, inclusive, with the exception of the last months of the 1930-31 and 1932-33 seasons, when prices were lower. The price trend of the 1930-31 season was perhaps the most nearly like the five-year average, until May, when it rapidly declined (Fig. 11).

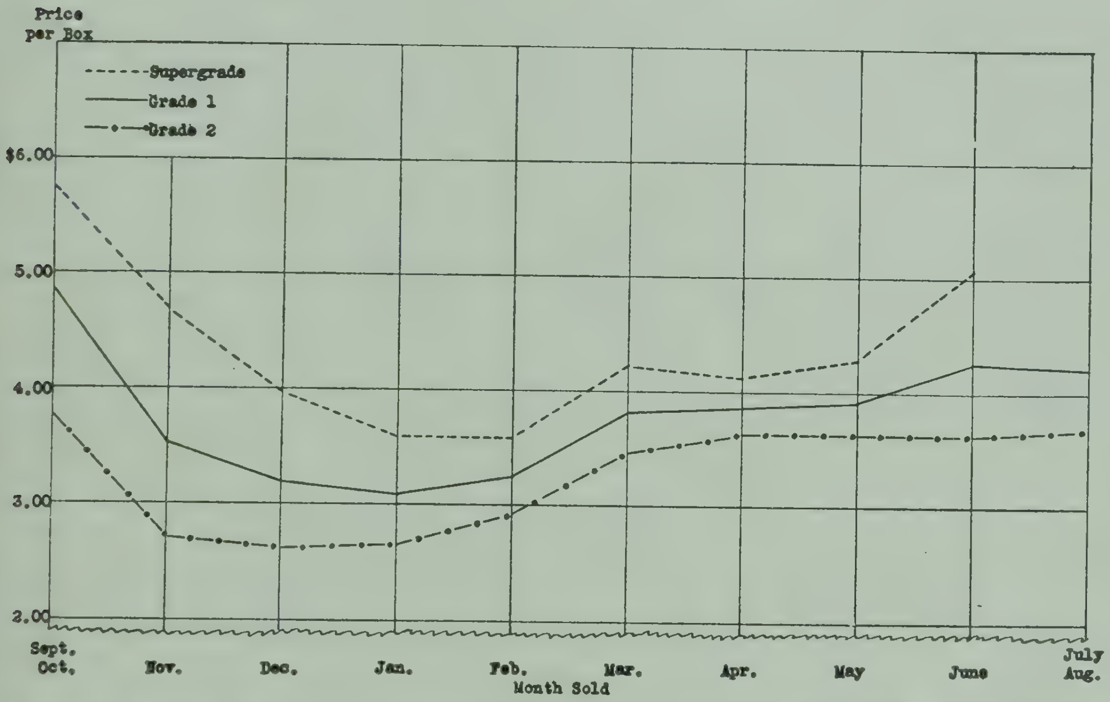

Fig. 8.—Monthly average auction prices of Florida oranges, all sizes, by grade, in five markets, 1930-31.

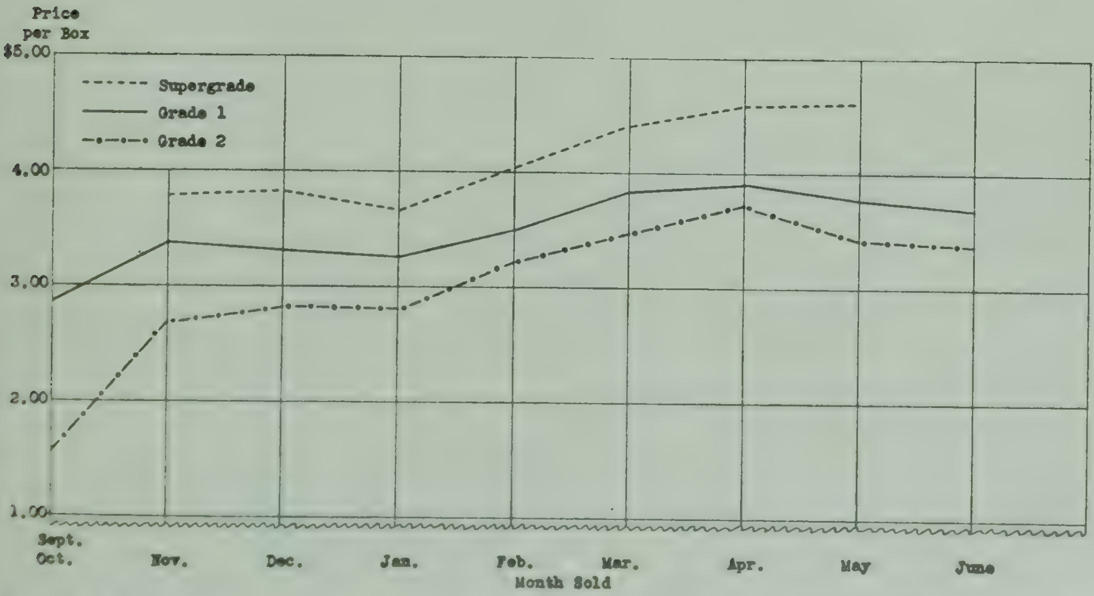

Fig. 9.—Monthly average auction prices of Florida oranges, all sizes, by grade, in five markets, 1931-32.

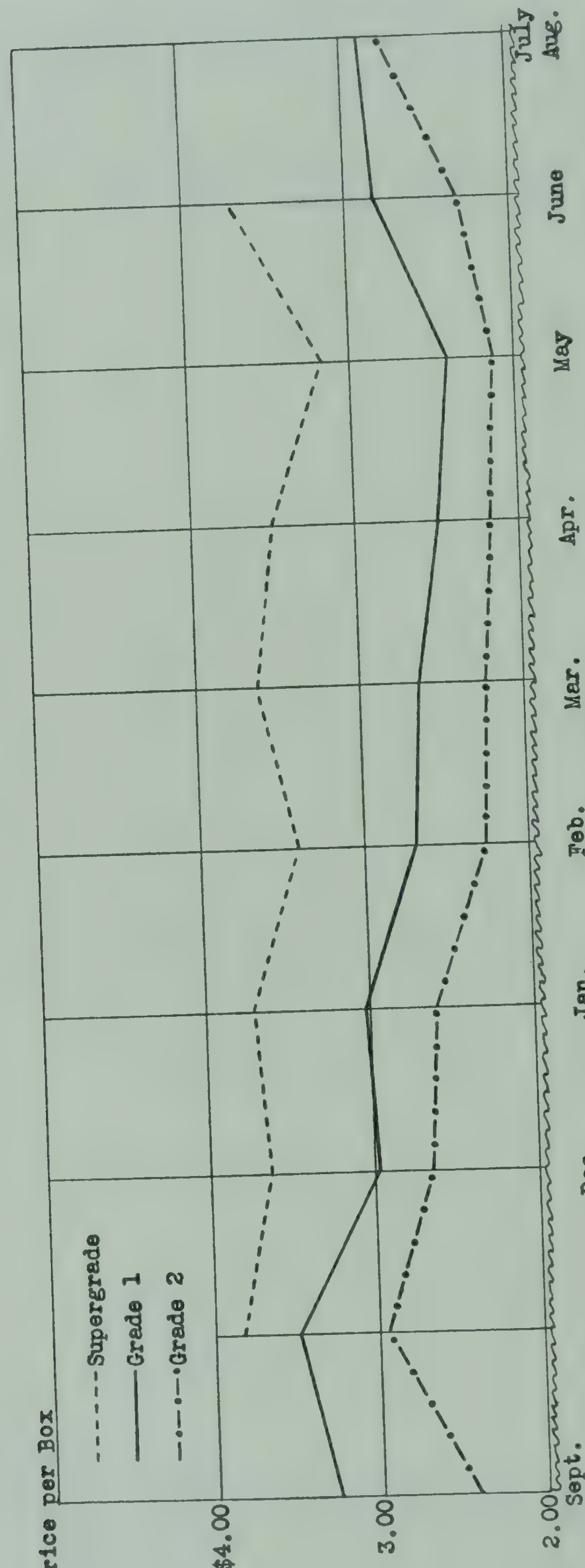

Fig. 10.—Monthly average auction prices of Florida oranges, all sizes, by grade, in five markets, 1932-33.

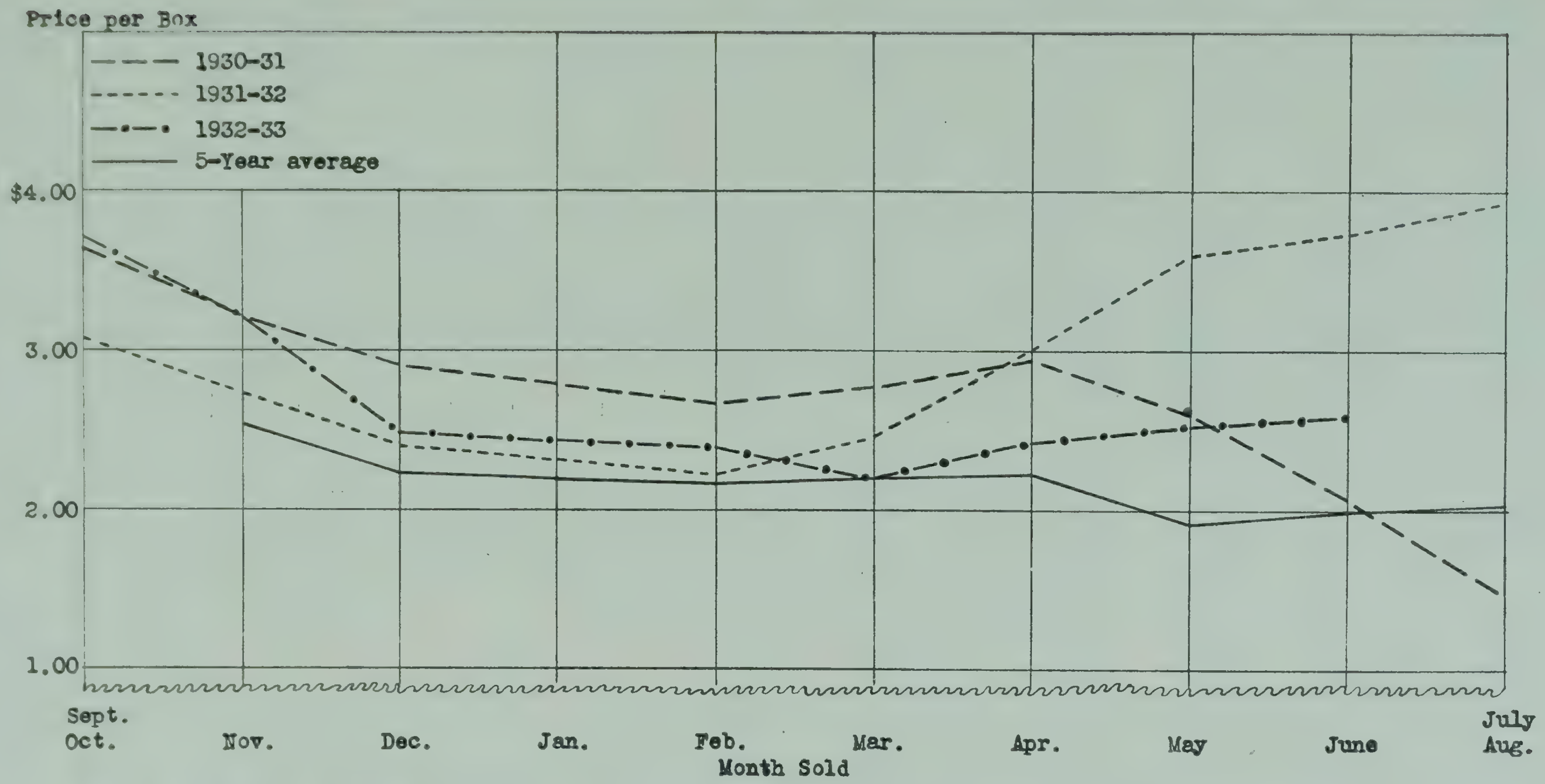

Fig. 11.—Monthly average auction prices of Florida grapefruit, all sizes, from 31 packinghouses to five markets, by seasons, compared with a 5-year average, 1931-32 to 1935-36, inclusive, of the total sales of Florida grapefruit in the same markets.

TABLE 5.—FLORIDA GRAPEFRUIT—MONTHLY AVERAGE AUCTION PRICES PER BOX, ALL SIZES, IN FIVE MARKETS, BY VARIETY AND GRADE.

Month Sold	Marsh Seedless																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
1930-31																		
September-October									81	$0.79	81	$0.79			206	$0.56	206	$0.56
November									26	3.77	26	3.77			39	3.46	39	3.46
December							517	$4.72	22	2.23	539	4.62	83	$4.46			83	4.46
January							1,034	4.39	1,838	3.44	2,872	3.78	182	3.26	934	2.93	1,116	2.98
February	15	$4.40			15	$4.40	4,728	3.15	1,211	3.00	5,939	3.12	356	2.87	1,894	2.61	2,250	2.65
March	612	3.03			612	3.03	6,653	3.62	2,099	2.90	8,752	3.45	799	2.60	1,774	3.00	2,573	2.88
April	1,445	3.72	152	$3.30	1,597	3.68	14,735	3.74	7,962	3.08	22,697	3.51	3,233	2.84	9,170	2.62	12,403	2.68
May	3,323	3.54	463	3.40	3,786	3.52	24,712	3.23	9,802	2.74	34,514	3.09	6,179	2.22	15,517	2.25	21,696	2.24
June	493	3.45	27	4.11	520	3.48	13,120	2.59	8,336	2.44	21,456	2.53	8,810	1.85	15,253	1.90	24,063	1.88
July-August							1,786	1.34	224	1.48	2,010	1.35	1,319	1.48	771	2.42	2,090	1.83
Total or average	5,888	$3.52	642	$3.41	6,530	$3.51	67,285	$3.23	31,601	$2.80	98,886	$3.09	20,961	$2.16	45,558	$2.26	66,519	$2.23
1931-32																		
September-October							23	$4.09			23	$4.09	21	$3.81			21	$3.81
November							691	3.14	154	$3.38	845	3.18	684	2.79	270	$2.61	954	2.74
December							1,758	3.19	358	2.59	2,116	3.09	582	2.51	469	2.37	1,051	2.45
January	610	$3.49			610	$3.49	1,297	3.03	595	2.54	1,892	2.88	250	2.81	725	2.06	975	2.25
February	2,240	2.93	53	$2.53	2,293	2.92	11,728	2.61	3,108	2.39	14,836	2.57	2,422	1.99	3,044	2.12	5,466	2.06
March	1,829	3.22	45	2.67	1,874	3.21	14,902	2.90	3,179	2.48	18,081	2.83	4,309	2.49	4,574	2.34	8,883	2.41
April	1,363	3.43	85	3.72	1,448	3.45	14,486	3.38	8,564	3.05	23,050	3.26	7,201	2.74	5,676	2.81	12,877	2.77
May							14,671	3.82	7,544	3.94	22,215	3.86	9,030	3.33	2,008	3.60	11,038	3.38
June							4,540	4.56	108	3.86	4,648	4.55	1,810	3.83	463	3.40	2,273	3.74
Total or average	6,042	$3.19	183	$3.11	6,225	$3.19	64,096	$3.30	23,610	$3.16	87,706	$3.26	26,309	$2.91	17,229	$2.62	43,538	$2.79
1932-33																		
September-October									16	$3.50	16	$3.50			22	$3.23	22	$3.23
November	223	$5.02			223	$5.02	1,370	$4.28	102	4.29	1,472	4.28	1,132	$3.67	121	3.02	1,253	3.60
December	30	3.80			30	3.80	1,149	3.36	2,369	4.05	3,518	3.82	1,705	2.49	1,354	3.13	3,059	2.77
January	255	4.55			255	4.55	1,755	3.40	388	3.87	2,143	3.48	1,193	2.15	168	3.02	1,361	2.26
February	490	4.20			490	4.20	3,373	3.43	1,209	3.47	4,582	3.44	1,766	2.28	1,447	2.85	3,213	2.54
March	841	3.80	32	$3.69	873	3.80	7,755	3.01	3,874	3.34	11,629	3.12	4,821	2.29	7,164	2.66	11,985	2.51
April	1,845	3.34			1,845	3.34	7,776	2.75	5,293	3.33	13,069	2.99	6,588	1.93	8,023	2.54	14,611	2.26
May	415	2.81	67	3.46	482	2.90	5,186	2.06	4,886	2.78	10,072	2.41	11,889	1.64	9,269	2.08	21,158	1.83
June			63	3.40	63	3.40	2,364	2.13	2,175	2.48	4,539	2.29	3,426	1.73	4,119	2.16	7,545	1.97
July August							3,708	2.54	664	2.12	4,372	2.48	10,517	2.00	853	1.94	11,370	2.00
Total or average	4,099	$3.65	162	$3.48	4,261	$3.65	34,436	$2.82	20,976	$3.18	55,412	$2.96	43,037	$1.98	32,540	$2.42	75,577	$2.17

TABLE 5.—FLORIDA GRAPEFRUIT—MONTHLY AVERAGE AUCTION PRICES PER BOX, ALL SIZES, IN FIVE MARKETS, BY VARIETY AND GRADE *(Concluded)*.

Month Sold	Other Varieties																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
1930-31																		
September-October							21,945	$4.12	12,224	$3.61	34,169	$3.94	5,702	$3.57	13,751	$3.02	19,453	$3.18
November	4,873	$3.52	1,144	$3.38	6,017	$3.49	27,073	3.52	16,417	3.02	43,490	3.33	6,674	2.98	10,874	2.69	17,548	2.80
December	1,944	3.55	529	3.40	2,473	3.52	24,234	3.23	18,589	2.85	42,823	3.07	5,069	2.71	15,699	2.39	20,768	2.47
January	3,294	3.20	73	3.71	3,367	3.21	28,957	3.06	20,388	2.80	49,345	2.95	5,681	2.38	26,525	2.41	32,206	2.40
February	1,022	3.14	27	3.44	1,049	3.15	23,084	2.92	11,667	2.67	34,751	2.84	3,258	2.34	16,855	2.21	20,113	2.23
March	3,673	2.94	257	2.88	3,930	2.94	23,376	2.82	12,219	2.66	35,595	2.76	1,380	2.26	13,250	2.33	14,630	2.32
April	3,466	3.52	188	3.06	3,654	3.50	19,116	2.92	5,176	2.67	24,292	2.86	7,865	2.46	11,776	2.28	19,641	2.35
May	304	3.41	92	3.57	396	3.44	17,744	2.40	4,696	2.48	22,440	2.42	5,958	1.90	7,356	1.97	13,314	1.94
June							8,569	1.86	1,642	2.15	10,211	1.91	5,489	1.31	3,247	1.82	8,736	1.50
July-August							211	.78			211	.78			360	.22	360	.22
Total or average	18,576	$3.33	2,310	$3.32	20,886	$3.33	194,309	$3.09	103,018	$2.88	297,327	$3.02	47,076	$2.47	119,693	$2.40	166,769	$2.42
1931-32																		
September-October							11,467	$3.32	9,359	$3.06	20,826	$3.21	2,667	$2.89	8,312	$2.81	10,979	$2.83
November	2,365	$3.33	721	$3.42	3,086	$3.36	24,627	3.02	11,282	2.72	35,909	2.93	11,028	2.40	12,605	2.34	23,633	2.37
December	2,808	2.88	366	2.84	3,174	2.87	29,125	2.57	8,148	2.47	37,273	2.54	15,213	2.06	10,439	2.13	25,652	2.09
January	2,359	2.66	352	2.90	2,711	2.69	25,281	2.45	12,027	2.33	37,308	2.41	11,528	1.99	9,441	1.99	20,969	1.99
February	934	2.54	259	2.72	1,193	2.58	25,121	2.23	5,486	2.21	30,607	2.23	12,328	1.75	4,177	1.98	16,505	1.81
March	868	2.57	18	2.83	886	2.58	17,480	2.50	5,216	2.18	22,696	2.42	9,647	2.02	4,174	2.02	13,821	2.02
April	852	3.67	75	3.56	927	3.66	7,124	2.87	2,383	3.16	9,507	2.94	4,574	2.48	2,544	2.86	7,118	2.62
May							1,849	3.42	1,422	3.69	3,271	3.54	2,009	3.15	727	2.87	2,736	3.08
June							585	4.61	54	3.61	639	4.52	1,338	3.43	679	2.33	2,017	3.06
July-August							509	4.81			509	4.81	1,191	3.54			1,191	3.54
Total or average	10,186	$2.94	1,791	$3.10	11,977	$2.97	143,168	$2.66	55,377	$2.60	198,545	$2.64	71,523	$2.18	53,098	$2.29	124,621	$2.23
1932-33																		
September-October			22	$4.55	22	$4.55	3,954	$3.71	5,596	$4.08	9,550	$3.93	2,148	$3.46	4,824	$3.37	6,972	$3.40
November	391	$3.73	680	3.45	1,071	3.55	15,984	3.27	9,777	3.55	25,761	3.38	11,216	2.89	9,599	2.87	20,815	2.88
December	788	3.56	892	2.53	1,180	3.22	18,093	2.47	9,907	3.11	28,000	2.70	19,317	1.95	14,283	2.38	33,600	2.14
January	643	3.70	14	3.21	657	3.69	10,748	2.53	5,399	2.86	16,147	2.64	8,870	1.91	10,160	2.31	19,030	2.12
February	464	3.38	13	2.85	477	3.37	10,886	2.37	5,582	2.85	16,468	2.53	9,915	1.72	11,943	2.24	21,858	2.00
March	617	3.07	89	3.18	706	3.09	11,106	2.12	2,754	2.63	13,860	2.22	17,660	1.45	13,709	1.95	31,369	1.67
April	162	3.08			162	3.08	6,546	2.10	1,005	1.85	7,551	2.06	11,514	1.53	6,589	1.79	18,103	1.63
May							1,861	1.93	1,602	1.98	3,463	1.95	4,908	1.36	2,104	1.46	7,012	1.39
June			185	2.70	185	2.70	1,367	2.23	328	2.84	1,695	2.35	3,089	1.53	1,558	1.65	4,647	1.57
July-August							1,266	2.06	256	2.54	1,522	2.14	6,753	1.71	990	2.03	7,743	1.76
Total or average	3,065	$3.46	1,395	$3.09	4,460	$3.34	81,811	$2.58	42,206	$3.16	124,017	$2.78	95,390	$1.86	75,759	$2.30	171,149	$2.06

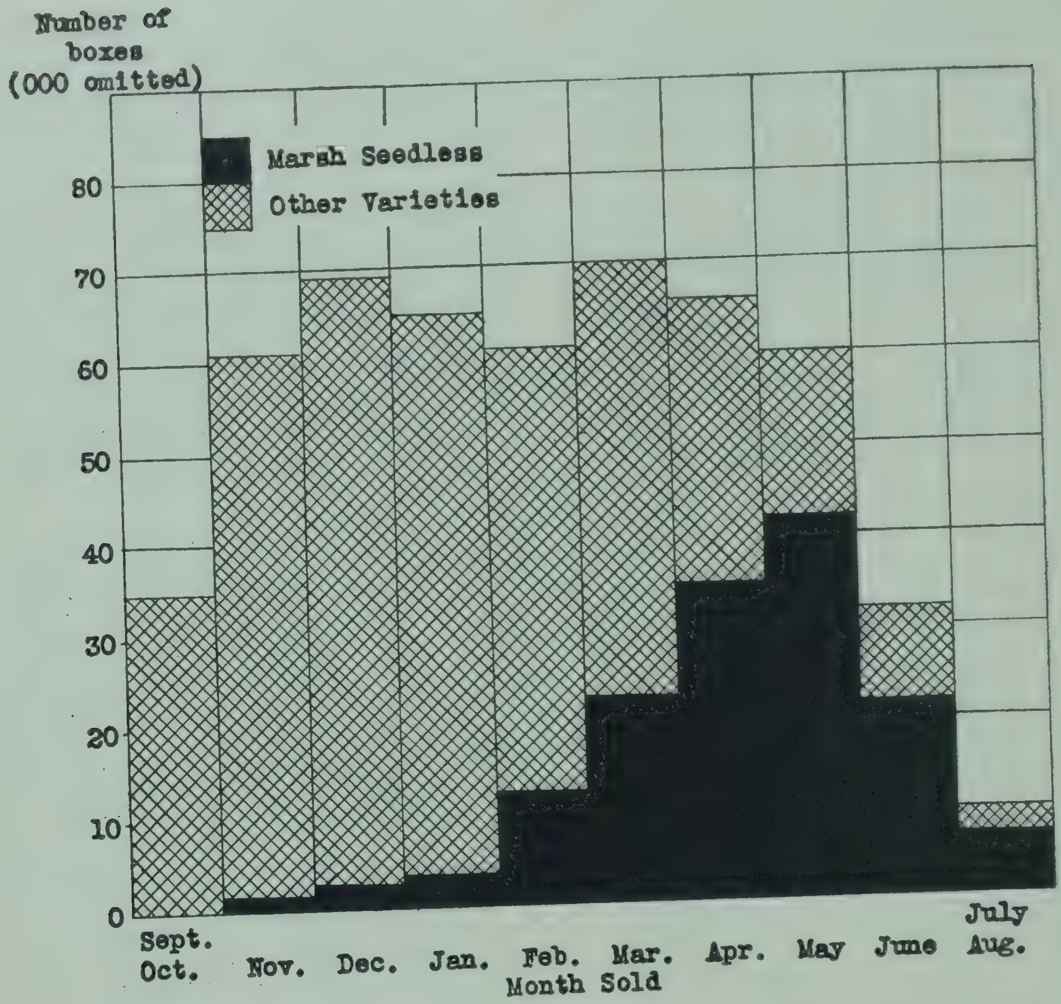

Fig. 12.—Seasonal distribution of auction sales of Florida grapefruit from 31 packinghouses to five markets (average of three seasons, 1930-31, 1931-32, and 1932-33).

A comparison of the average auction price of Marsh Seedless and "Other Varieties" of grapefruit, by grade, is given in Table 5. In 1932-33 the prices were usually higher in the "Other Markets" than in New York for both Marsh Seedless and "Other Varieties". In 1930-31 and 1931-32 the New York auction usually paid the higher price. Most of the exceptions noted are in grade 2 fruit.

All grades have been combined in Table 6 to obtain a variety price. Third grade fruit, not previously shown, is included. Marsh Seedless grapefruit brought a higher average price than the "Other Varieties", although in 1930-31 the season average price was lower. This, however, was due to the generally downward trend of grapefruit prices that season which gave the "Other Varieties" an advantage in price because of the difference in seasonal distribution (Fig. 12). In every month of 1930-

TABLE 6.—FLORIDA GRAPEFRUIT—MONTHLY AVERAGE AUCTION PRICES PER BOX, ALL SIZES, IN FIVE MARKETS, BY VARIETY, ALL GRADES COMBINED.[1]

Month Sold	Marsh Seedless						Other Varieties						All Varieties					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
1930-31																		
September-October			287	$0.63	287	$0.63	27,763	$4.01	26.446	$3.29	54,209	$3.66	27,763	$4.01	26,733	$3.26	54,496	$3.64
November			65	3.58	65	3.58	38,700	3.42	28,501	2.91	67,201	3.21	38,700	3.42	28,566	2.91	67,266	3.21
December	600	$4.69	22	2.23	622	4.60	31,247	3.17	34,817	2.65	66.064	2.90	31,847	3.20	34,839	2.65	66,686	2.91
January	1,216	4.22	3,132	3.16	4,348	3.46	37,932	2.97	46,986	2.58	84,918	2.75	39,148	3.01	50,118	2.62	89,266	2.79
February	5,099	3.14	3,477	2.62	8,576	2.93	27,364	2.86	28,549	2.40	55,913	2.63	32,463	2.91	32,026	2.43	64,489	2.67
March	8,064	3.47	4,050	2.93	12,114	3.29	28,429	2.81	26,579	2.48	55,008	2.65	36,493	2.96	30,629	2.54	67,122	2.77
April	19,413	3.59	17,421	2.83	36,834	3.23	30,447	2.87	17,543	2.41	47,990	2.70	49,860	3.15	34,964	2.62	84,824	2.93
May	34,214	3.08	25,822	2.45	60,036	2.81	24,006	2.29	12,572	2.16	36,578	2.24	58,220	2.75	38,394	2.36	96,614	2.59
June	22,426	2.31	23,693	2.09	46,119	2.20	14,059	1.65	4,889	1.93	18,948	1.72	36,485	2.06	28,582	2.06	65,067	2.06
July-August	3,105	1.40	995	2.21	4,100	1.60	211	.78	360	.22	571	.43	3,316	1.36	1,355	1.68	4,671	1.45
Total or average	94,137	$3.01	78,964	$2.48	173,101	$2.77	260.158	$3.00	227,242	$2.63	487,400	$2.82	354.295	$3.00	306,206	$2.59	660,501	$2.81
1931-32																		
September-October	44	$3.95			44	$3.95	14,201	$3.24	17,927	$2.94	32,128	$3.07	14,245	$3.24	17,927	$2.94	32,172	$3.07
November	1,375	2.96	424	$2.89	1,799	2.95	38,091	2.86	24,665	2.54	62,756	2.73	39,466	2.86	25,089	2.55	64,555	2.74
December	2,340	3.02	827	2.47	3,167	2.87	47,146	2.42	18,954	2.29	66,100	2.38	49,486	2.45	19,781	2.29	69,267	2.40
January	2,157	3.13	1,320	2.27	3,477	2.81	39,168	2.33	22,049	2.18	61,217	2.28	41,325	2.37	23,369	2.19	64,694	2.31
February	16,390	2.56	6,205	2.26	22,595	2.48	38,383	2.09	9,922	2.13	48,305	2.10	54,773	2.23	16,127	2.18	70,900	2.22
March	21,162	2.84	8,133	2.37	29,295	2.71	28,164	2.33	9,767	2.09	37,931	2.27	49,326	2.55	17,900	2.22	67,226	2.46
April	23,213	3.18	15,744	2.94	38,957	3.08	12,581	2.78	5,502	2.89	18,083	2.81	35,794	3.04	21,246	2.93	57,040	3.00
May	24,767	3.61	10,920	3.78	35,687	3.66	3,858	3.28	2,736	3.22	6,594	3.25	28,625	3.56	13,656	3.67	42,281	3.60
June	6,350	4.35	1,054	3.39	7,404	4.22	1,924	3.78	2,452	2.20	4,376	2.90	8,274	4.22	3,506	2.56	11,780	3.73
July-August							1,700	3.92			1,700	3.92	1,700	3.92			1,700	3.92
Total or average	97,798	$3.18	44,627	$2.93	142.425	$3.10	225.216	$2.52	113,974	$2.44	339,190	$2.49	323,014	$2.72	158,601	$2.58	481,615	$2.67
1932-33																		
September-October			38	$3.34	38	$3.34	6,152	$3.62	10,822	$3.74	16,974	$3.70	6,152	$3.62	10,860	$3.74	17,012	$3.70
November	2,725	$4.09	223	3.60	2,948	4.05	27,644	3.12	20,715	3.19	48,359	3.15	30,369	3.21	20,938	3.19	51,307	3.20
December	2,924	2.86	3,723	3.71	6,647	3.34	38,387	2.23	24,686	2.68	63,073	2.40	41,311	2.27	28,409	2.81	69,720	2.49
January	3,203	3.03	556	3.61	3,759	3.11	20,953	2.27	15,636	2.50	36,589	2.37	24,156	2.37	16,192	2.54	40,348	2.44
February	5,638	3.13	2,930	3.08	8,568	3.11	21,809	2.08	18,164	2.43	39,973	2.24	27,447	2.29	21,094	2.52	48,541	2.39
March	14,161	2.76	12,693	2.83	26,854	2.79	29,634	1.74	18,192	2.03	47,826	1.85	43,795	2.07	30,885	2.36	74,680	2.19
April	16,209	2.49	13,864	2.81	30,073	2.64	18,222	1.75	7,661	1.80	25,883	1.76	34,431	2.10	21,525	2.45	55,956	2.23
May	17,490	1.79	14,222	2.33	31,712	2.03	6,769	1.51	3,706	1.69	10,475	1.58	24,259	1.71	17,928	2.20	42,187	1.92
June	5,790	1.89	6,357	2.28	12,147	2.10	4,456	1.74	2,071	1.93	6,527	1.80	10,246	1.83	8,428	2.20	18,674	1.99
July-August	14,225	2.14	1,517	2.02	15,742	2.13	8,019	1.77	1,246	2.14	9,265	1.82	22,244	2.01	2,763	2.07	25,007	2.02
Total or average	82,365	$2.42	56,123	$2.70	138,488	$2.53	182,045	$2.21	122,899	$2.60	304,944	$2.37	264,410	$2.28	179,022	$2.63	443,432	$2.42

[1] Includes a small amount of Grade 3 fruit.

31, except September-October, Marsh Seedless received a premium in New York over the price received for "Other Varieties". This was true in "Other Markets" also if December be eliminated when only 22 boxes of Marsh Seedless were sold (Figs. 13, 14, and 15).

Because of the proportionately larger shipments of high grade fruit to New York than to the "Other Markets", comparisons of price between New York and "Other Markets" should be made only within the same variety and grade.

In Table 7 is shown the average prices of grapefruit by grade, irrespective of variety (Figs. 16, 17, and 18). The average premium paid for supergrade over grade 1 was smaller in dollars for grapefruit than for oranges, and averaged 40 cents per box for the three seasons—the largest difference occurring in 1932-33. Grade 1 grapefruit brought an average of 62 cents per box more than grade 2, with the greatest difference also in 1932-33.

MONTHLY AVERAGE PRICES OF MANDARINS

The monthly average price received for Florida mandarins sold at auction is shown by grades in Table 8; and the average variety price, including a small amount of third grade fruit, in Table 9. Temple oranges were sold mainly in the months of January, February, March, and April, while the tangerine season began in November and was practically over by April (Fig. 19).

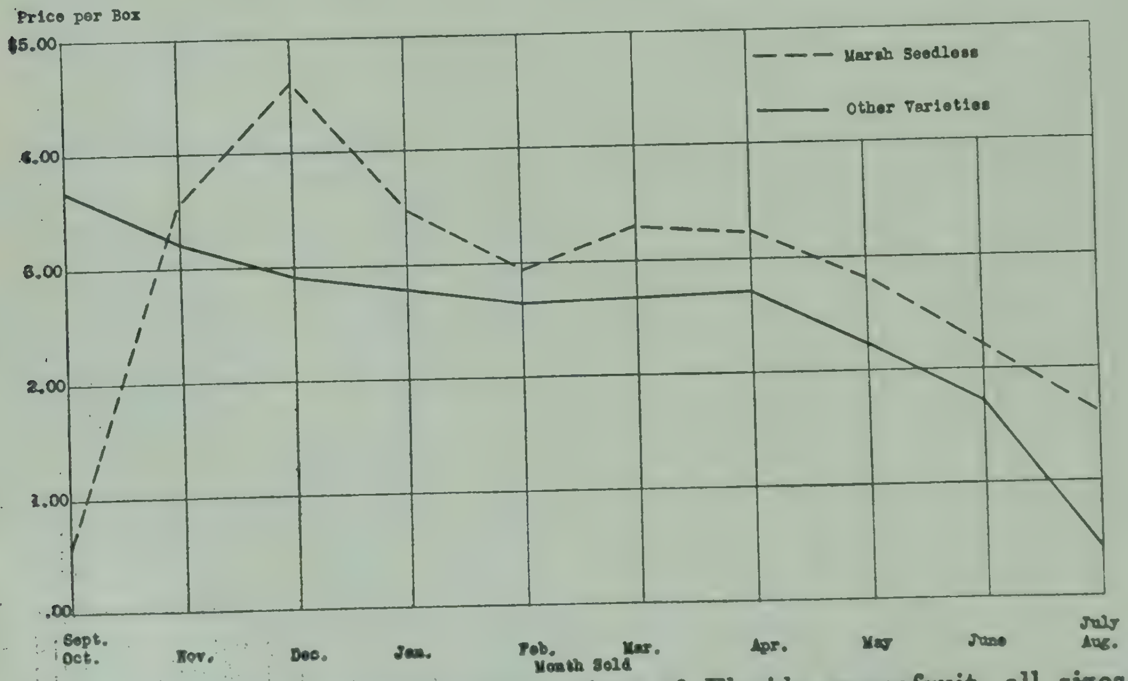

Fig. 13.—Monthly average auction prices of Florida grapefruit, all sizes, by variety, in five markets, 1930-31.

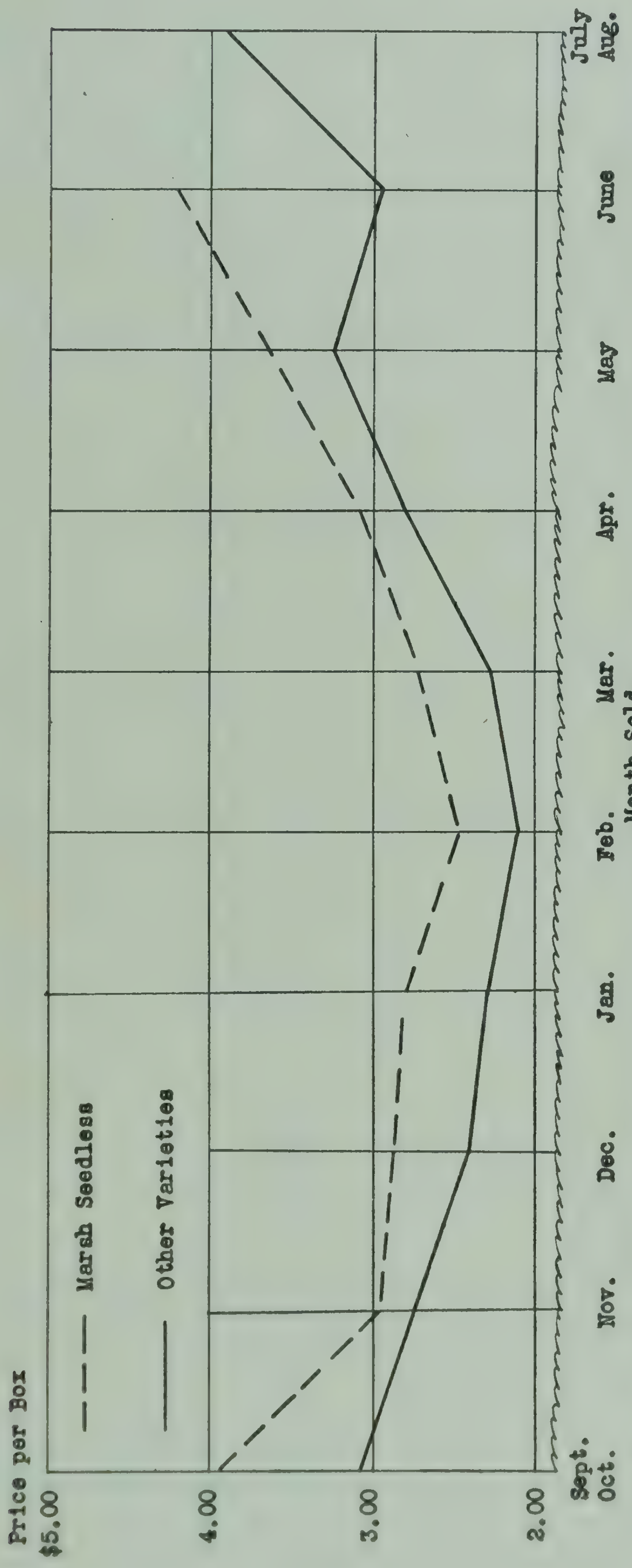

Fig. 14.—Monthly average auction prices of Florida grapefruit, all sizes, by variety, in five markets, 1931-32.

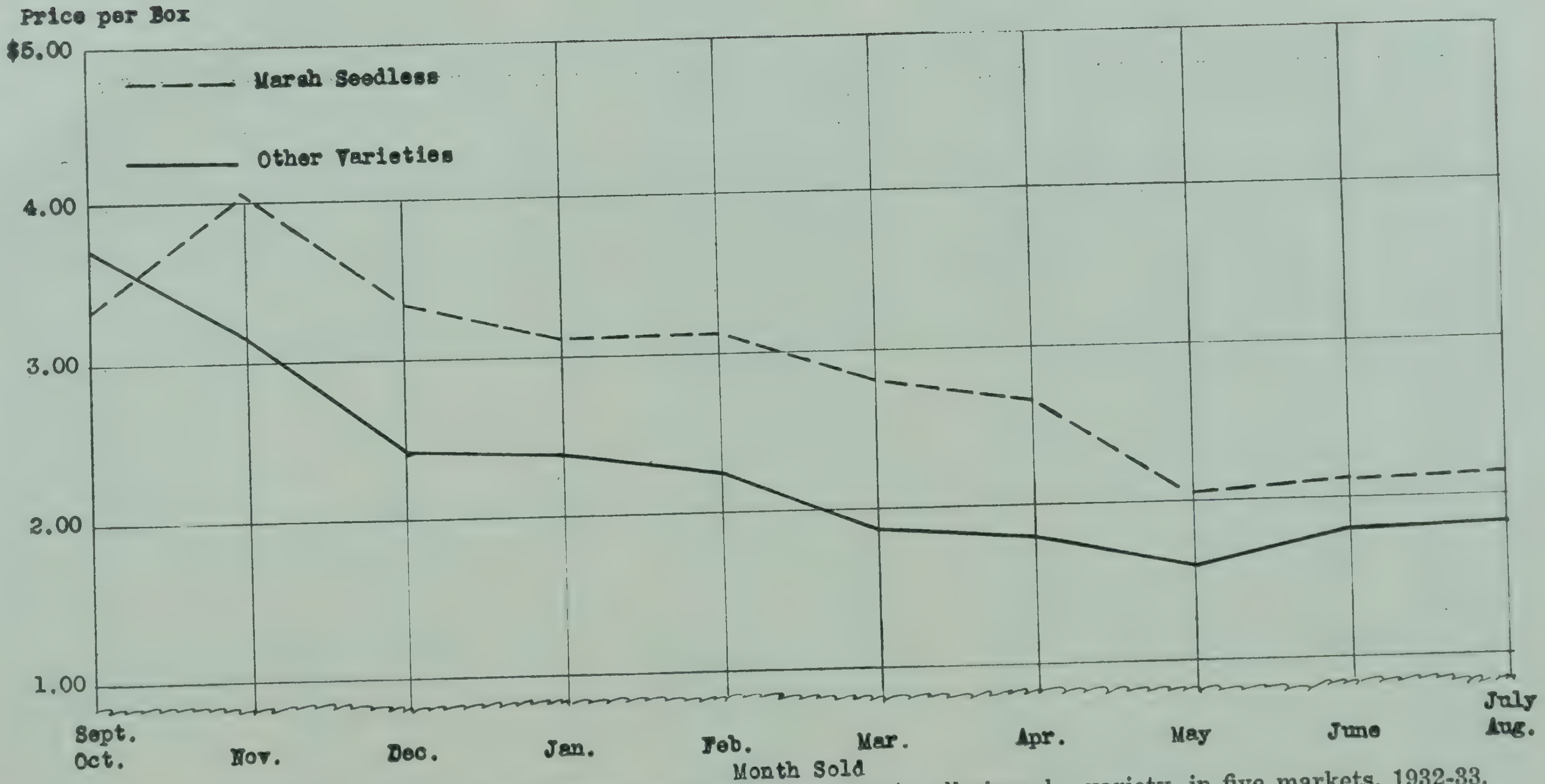

Fig. 15.—Monthly average auction prices of Florida grapefruit, all sizes, by variety, in five markets, 1932-33.

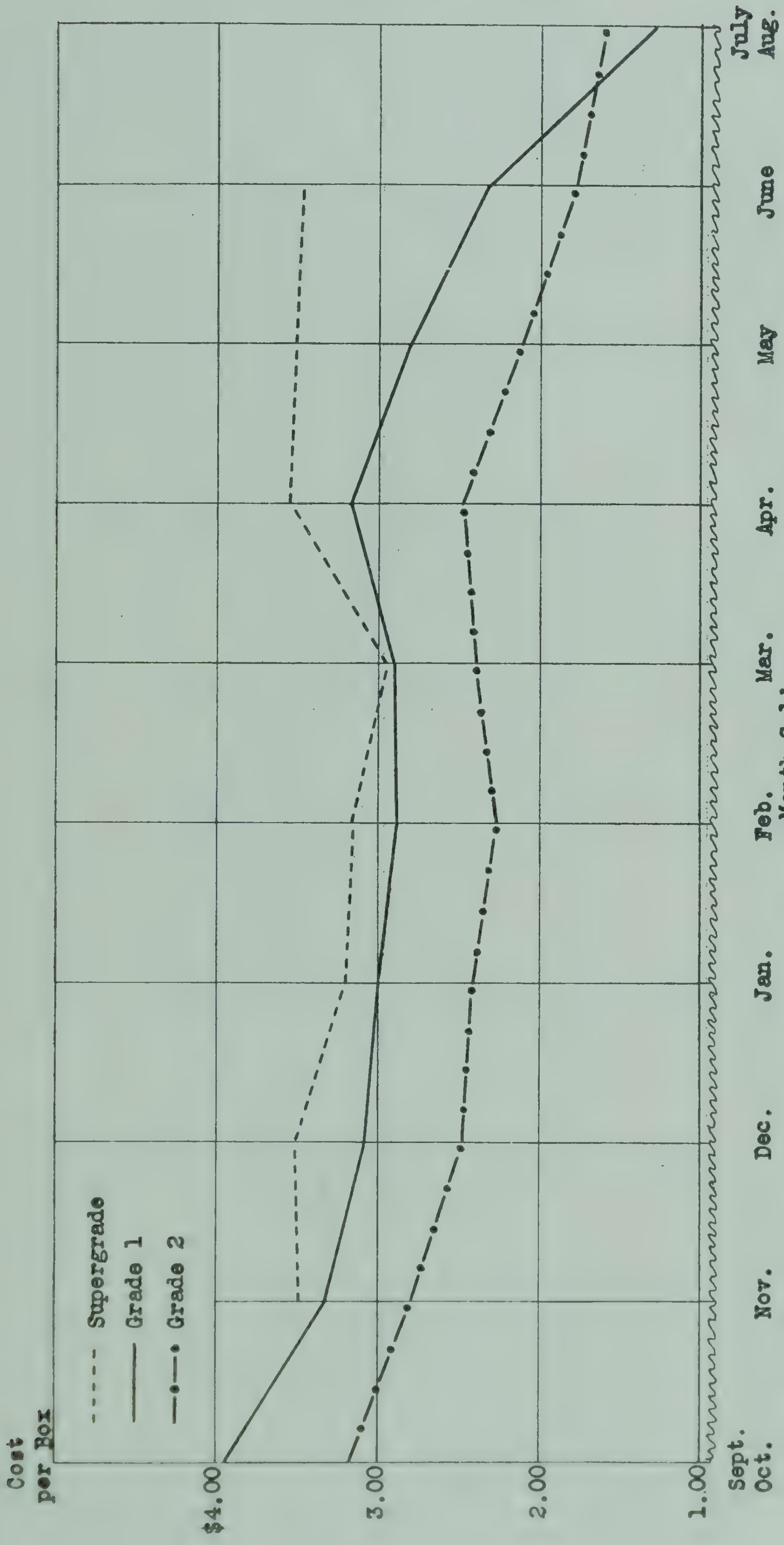

Fig. 16.—Monthly average auction prices of Florida grapefruit, all sizes, by grade, in five markets, 1930-31.

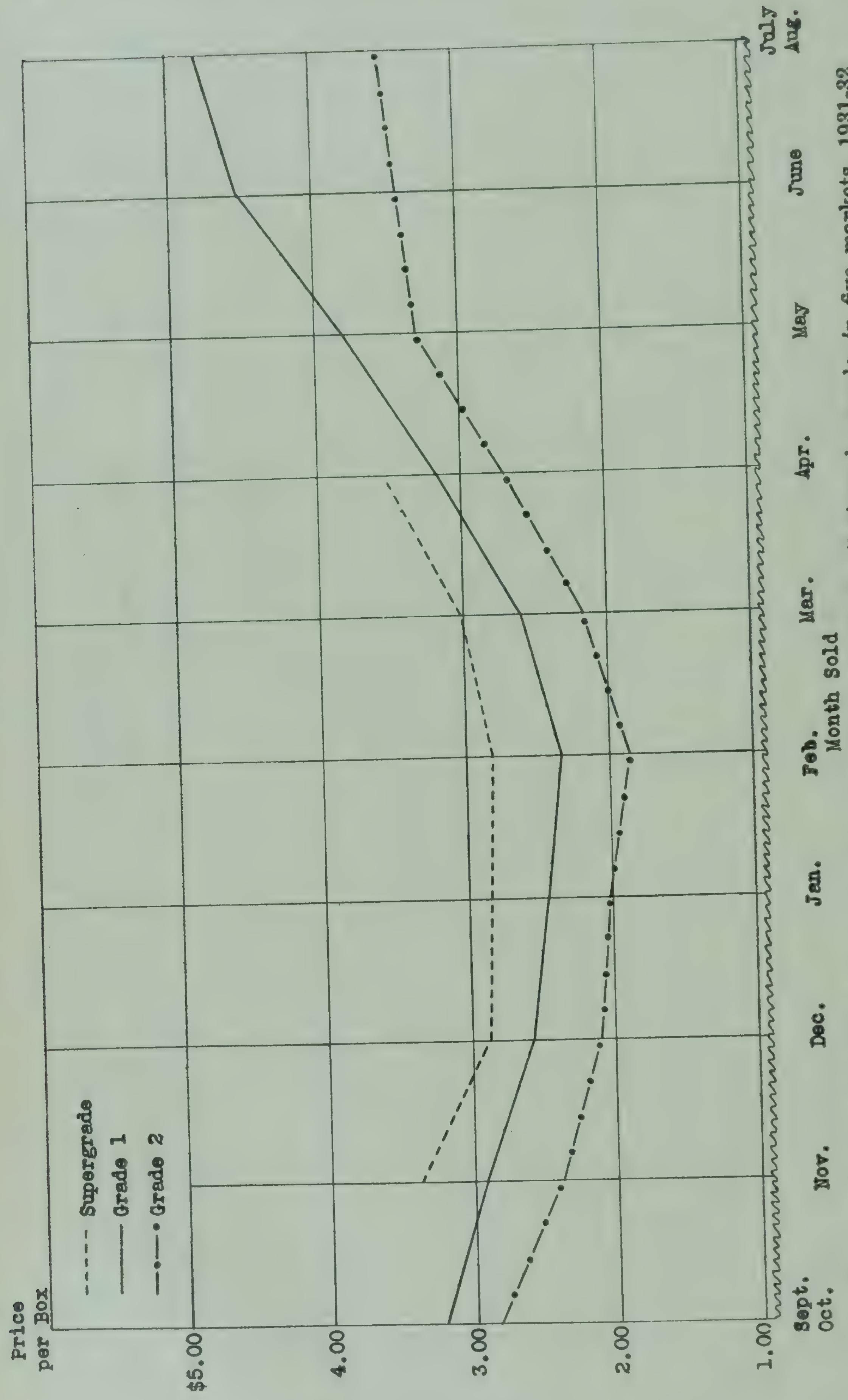

Fig. 17.—Monthly average auction prices of Florida grapefruit, all sizes, by grade, in five markets, 1931-32.

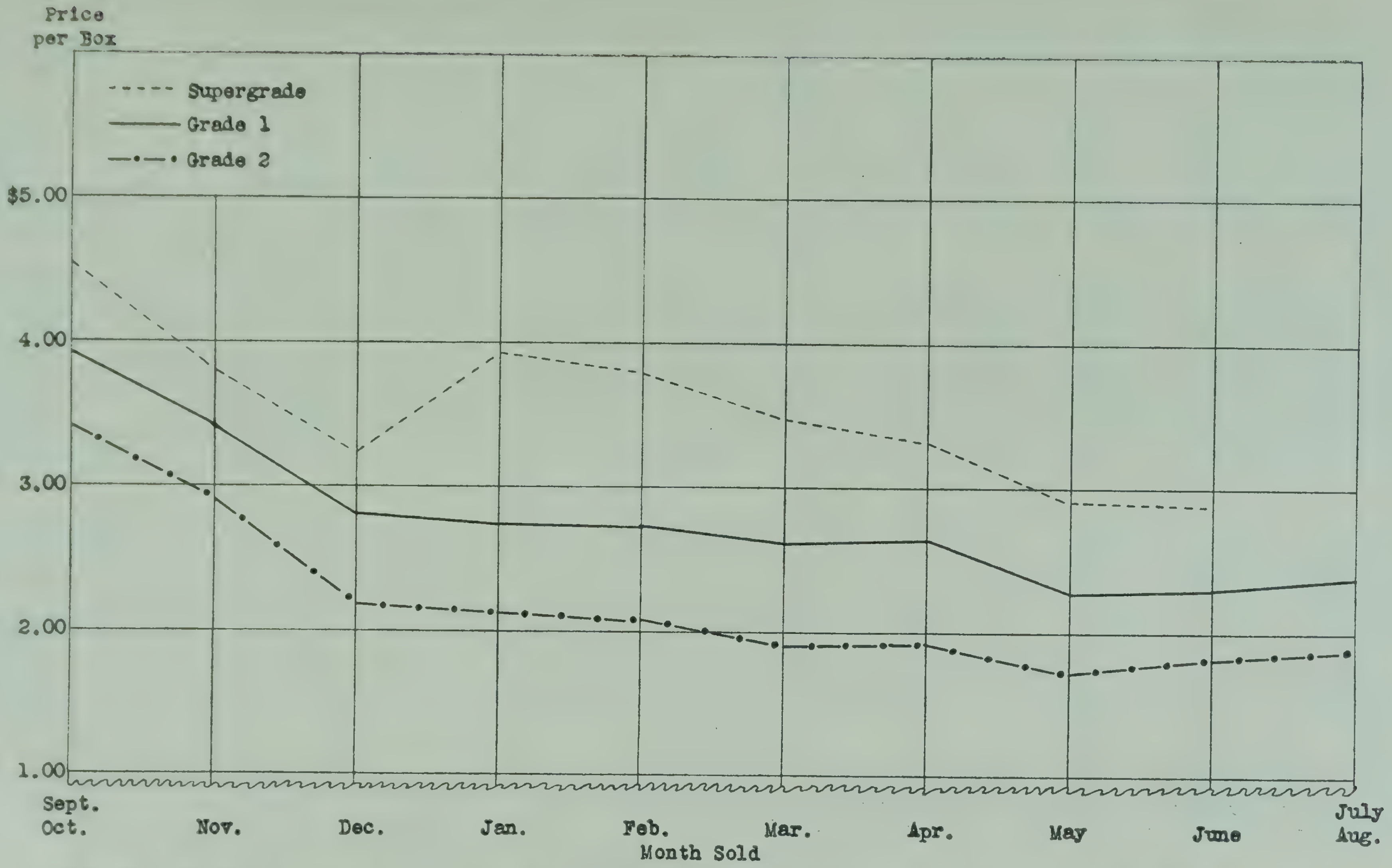

Fig. 18.—Monthly average auction prices of Florida grapefruit, all sizes, by grade, in five markets, 1932-33.

TABLE 7.—FLORIDA GRAPEFRUIT—MONTHLY AVERAGE AUCTION PRICES PER BOX, ALL SIZES, IN FIVE MARKETS, BY GRADE, ALL VARIETIES COMBINED.

Month Sold	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
1930-31																		
September-October							21,945	$4.12	12,305	$3.59	34,250	$3.93	5,702	$3.57	13,957	$2.99	19,659	$3.16
November	4,873	$3.52	1,144	$3.38	6,017	$3.49	27,073	3.52	16,443	3.02	43,516	3.33	6,674	2.98	10,913	2.70	17,587	2.80
December	1,944	3.55	529	3.40	2,473	3.52	24,751	3.26	18,611	2.85	43,362	3.09	5,152	2.74	15,699	2.39	20,851	2.48
January	3,294	3.20	73	3.71	3,367	3.21	29,991	3.10	22,226	2.85	52,217	3.00	5,863	2.41	27,459	2.42	33,322	2.42
February	1,037	3.16	27	3.44	1,064	3.16	27,812	2.96	12,878	2.70	40,690	2.88	3,614	2.40	18,749	2.25	22,363	2.27
March	4,285	2.95	257	2.88	4,542	2.95	30,029	3.00	14,318	2.69	44,347	2.90	2,179	2.39	15,024	2.41	17,203	2.41
April	4,911	3.58	340	3.17	5,251	3.55	33,851	3.28	13,138	2.92	46,989	3.18	11,098	2.57	20,946	2.43	32,044	2.48
May	3,627	3.53	555	3.43	4,182	3.51	42,456	2.88	14,498	2.66	56,954	2.83	12,137	2.06	22,873	2.16	35,010	2.12
June	493	3.45	27	4.11	520	3.48	21,689	2.30	9,978	2.39	31,667	2.33	14,299	1.64	18,500	1.89	32,799	1.78
July-August							1,997	1.28	224	1.48	2,221	1.30	1,319	1.48	1,131	1.72	2,450	1.59
Total or average	24,464	$3.38	2,952	$3.34	27,416	$3.37	261,594	$3.13	134,619	$2.86	396,213	$3.04	68,037	$2.37	165,251	$2.36	233,288	$2.37
1931-32																		
September-October							11,490	$3.33	9,359	$3.06	20,849	$3.21	2,688	$2.90	8,312	$2.81	11,000	$2.83
November	2,365	$3.33	721	$3.42	3,086	$3.36	25,318	3.02	11,436	2.73	36,754	2.93	11,712	2.42	12,875	2.34	24,587	2.38
December	2,808	2.88	366	2.84	3,174	2.87	30,883	2.60	8,506	2.47	39,389	2.57	15,795	2.07	10,908	2.14	26,703	2.10
January	2,969	2.83	352	2.90	3,321	2.84	26,578	2.48	12,622	2.34	39,200	2.44	11,778	2.01	10,166	2.00	21,944	2.01
February	3,174	2.82	312	2.69	3,486	2.80	36,849	2.35	8,594	2.28	45,443	2.34	14,750	1.79	7,221	2.04	21,971	1.87
March	2,697	3.01	63	2.71	2,760	3.00	32,382	2.68	8,395	2.29	40,777	2.60	13,956	2.16	8,748	2.19	22,704	2.17
April	2,215	3.52	160	3.64	2,375	3.53	21,610	3.21	10,947	3.07	32,557	3.16	11,775	2.64	8,220	2.83	19,995	2.72
May							16,520	3.77	8,966	3.90	25,486	3.82	11,039	3.30	2,735	3.40	13,774	3.32
June							5,125	4.57	162	3.78	5,287	4.54	3,148	3.66	1,142	2.76	4,290	3.42
July-August							509	4.81			509	4.81	1,191	3.54			1,191	3.54
Total or average	16,228	$3.03	1,974	$3.10	18,202	$3.04	207,264	$2.86	78,987	$2.77	286,251	$2.83	97,832	$2.38	70,327	$2.37	168,159	$2.37
1932-33																		
September-October			22	$4.55	22	$4.55	3,954	$3.71	5,612	$4.07	9,566	$3.92	2,148	$3.46	4,846	$3.37	6,994	$3.39
November	614	$4.20	680	3.45	1,294	3.80	17,354	3.35	9,879	3.55	27,233	3.43	12,348	2.96	9,720	2.87	22,068	2.92
December	818	3.57	392	2.53	1,210	3.24	19,242	2.53	12,276	3.29	31,518	2.82	21,022	2.00	15,637	2.45	36,659	2.19
January	898	3.94	14	3.21	912	3.93	12,503	2.65	5,787	2.93	18,290	2.74	10,063	1.94	10,328	2.32	20,391	2.13
February	954	3.80	13	2.85	967	3.79	14,259	2.62	6,791	2.96	21,050	2.73	11,681	1.80	13,390	2.30	25,071	2.07
March	1,458	3.49	121	3.31	1,579	3.48	18,861	2.49	6,628	3.05	25,489	2.63	22,481	1.63	20,873	2.20	43,354	1.90
April	2,007	3.32			2,007	3.32	14,322	2.45	6,298	3.10	20,620	2.65	18,102	1.68	14,612	2.20	32,714	1.91
May	415	2.81	67	3.46	482	2.90	7,047	2.02	6,488	2.58	13,535	2.29	16,797	1.55	11,373	1.97	28,170	1.72
June			248	2.88	248	2.88	3,731	2.17	2,503	2.52	6,234	2.31	6,515	1.63	5,677	2.02	12,192	1.81
July-August							4,974	2.42	920	2.24	5,894	2.39	17,270	1.89	1,843	1.99	19,113	1.90
Total or average	7,164	$3.57	1,557	$3.13	8,721	$3.49	116,247	$2.65	63,182	$3.17	179,429	$2.83	138,427	$1.90	108,299	$2.33	246,726	$2.09

TABLE 8.—FLORIDA MANDARINS—MONTHLY AVERAGE AUCTION PRICES PER HALF-BOX, ALL SIZES, IN FIVE MARKETS, BY VARIETY AND GRADE.

Month Sold	Temple																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price
1930-31																		
November							151	$1.69			151	$1.69			145	$0.72	145	$0.72
December															52	1.10	52	1.10
January	16	$2.56			16	$2.56	38	2.16	165	$1.25	203	1.42	123	$1.52	11	1.64	134	1.53
February	157	2.78	20	$2.65	177	2.76	1,899	3.34	1,616	2.45	3,515	2.93	1,595	2.92	1,044	2.21	2,639	2.64
March	428	3.48	19	3.32	447	3.47	779	3.30	280	2.72	1,059	3.15	902	3.00	349	3.05	1,251	3.01
April							9	3.67			9	3.67	1	2.00	6	2.00	7	2.00
May							10	.70			10	.70						
Total or average	601	$3.27	39	$2.97	640	$3.25	2,886	$3.22	2,061	$2.39	4,947	$2.87	2,621	$2.88	1,607	$2.21	4,228	$2.63
1931-32																		
December							116	$1.57			116	$1.57						
January							351	2.24			351	2.24	403	$1.66			403	$1.66
February	193	$2.15	106	$2.13	299	$2.14	2,640	1.89	2,415	$2.07	5,055	1.98	826	1.57	1,057	$2.07	1,883	1.85
March	121	2.26	8	2.50	129	2.28	1,021	2.41	208	2.25	1,229	2.38	1,955	2.18	301	2.08	2,256	2.17
April	4	2.25			4	2.25	1,247	2.83			1,247	2.83	1,024	2.47			1,024	2.47
May							60	1.13			60	1.13	35	.89			35	.89
Total or average	318	$2.19	114	$2.16	432	$2.19	5,435	$2.21	2,623	$2.08	8,058	$2.17	4,243	$2.07	1,358	$2.07	5,601	$2.07
1932-33																		
December							71	$1.55			71	$1.55	32	$1.34			32	$1.34
January	25	$2.12			25	$2.12	1,093	1.94			1,093	1.94	689	1.77	182	$1.59	871	1.73
February							1,488	1.63	302	$1.69	1,790	1.64	1,420	1.17	1,004	1.67	2,424	1.38
March	74	2.26			74	2.26	2,562	1.91	508	1.49	3,070	1.84	812	1.51	2,359	1.41	3,171	1.44
April							1,837	1.73	165	1.22	2,002	1.68	2,532	1.14	1,824	1.31	4,356	1.21
Total or average	99	$2.22			99	$2.22	7,051	$1.80	975	$1.51	8,026	$1.77	5,485	$1.28	5,369	$1.43	10,854	$1.36

TABLE 8.—FLORIDA MANDARINS—MONTHLY AVERAGE AUCTION PRICES PER HALF-BOX, ALL SIZES, IN FIVE MARKETS, BY VARIETY AND GRADE *(Concluded)*.

Month Sold	Tangerines																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price
1930-31																		
November	273	$2.32	180	$2.02	453	$2.20	20,379	$2.03	14,761	$1.98	35,140	$2.01	1,998	$1.87	9,662	$1.65	11,660	$1.69
December	4,456	2.17	1,815	2.08	6,271	2.15	35,078	1.69	17,845	1.67	52,923	1.68	3,774	1.61	8,349	1.41	12,123	1.47
January	2,311	2.01	702	1.57	3,013	1.91	41,645	1.42	10,958	1.45	52,603	1.43	2,377	1.57	8,737	1.23	11,114	1.30
February	3,489	1.86	150	1.89	3,639	1.86	28,797	1.60	7,180	1.40	35,977	1.56	2,517	1.58	13,641	1.27	16,158	1.32
March	1,265	1.92	63	1.78	1,328	1.91	10,030	1.47	314	1.63	10,344	1.48	3,766	1.40	779	1.41	4,545	1.40
April							207	.37			207	.37						
May																		
Total or average	11,794	$2.02	2,910	$1.94	14,704	$2.01	136,136	$1.62	51,058	$1.67	187,194	$1.63	14,432	$1.58	41,168	$1.38	55,600	$1.43
1931-32																		
November	288	$2.04			288	$2.04	17,888	$2.03	6,719	$1.77	24,607	$1.96	5,747	$2.02	846	$1.53	6,593	$1.95
December	3,733	1.79	726	$1.76	4,459	1.79	48,506	1.57	11,693	1.68	60,199	1.59	9,481	1.33	7,592	1.47	17,073	1.39
January	3,802	1.44	1,588	1.65	5,390	1.50	47,362	1.39	7,439	1.36	54,801	1.39	14,480	1.07	10,302	1.19	24,782	1.12
February	343	1.87	403	1.61	746	1.73	30,540	1.72	3,844	1.47	34,384	1.69	16,995	1.49	2,626	1.58	19,621	1.51
March	143	1.92			143	1.92	3,950	1.89	114	1.43	4,064	1.88	3,530	1.75	112	1.40	3,642	1.74
April							335	2.01			335	2.01	344	1.50			344	1.50
May							63	1.22			63	1.22	96	1.03			96	1.03
Total or average	8,309	$1.65	2,717	$1.68	11,026	$1.65	148,644	$1.61	29,809	$1.59	178,453	$1.61	50,673	$1.42	21,478	$1.35	72,151	$1.40
1932-33																		
September-October													7	$1.86			7	$1.86
November	215	$2.61	430	$1.46	645	$1.84	10,945	$1.93	1,569	$1.40	12,514	$1.86	5,105	1.56	1,200	$1.14	6,305	1.48
December	2,732	1.70	870	1.50	3,102	1.67	25,273	1.29	8,152	1.41	33,425	1.32	3,733	1.22	4,853	1.13	8,586	1.17
January	3,321	1.47	417	1.36	3,738	1.46	16,931	1.25	9,120	1.26	26,051	1.26	5,178	1.17	11,030	1.06	16,208	1.09
February	72	1.54	119	1.78	191	1.69	8,154	1.13	4,314	1.21	12,468	1.16	6,991	.79	7,690	1.17	14,681	.99
March	60	1.63	6	1.33	66	1.61	9,277	1.19	4,040	1.12	13,317	1.17	8,490	1.06	10,432	1.07	18,922	1.07
April							906	1.16			906	1.16	3,263	.95			3,263	.95
Total or average	6,400	$1.61	1,342	$1.47	7,742	$1.58	71,486	$1.35	27,195	$1.29	98,681	$1.33	32,767	$1.11	35,205	$1.10	67,972	$1.10

TABLE 9.—FLORIDA MANDARINS—MONTHLY AVERAGE AUCTION PRICES PER HALF-BOX, ALL SIZES, IN FIVE MARKETS, BY VARIETY, ALL GRADES COMBINED[1].

Month Sold	Temple						Tangerines					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price	Half-boxes	Price
1930-31												
November	151	$1.69	145	$0.72	296	$1.21	22,650	$2.02	24,603	$1.85	47,253	$1.93
December			52	1.10	52	1.10	43,347	1.73	28,009	1.62	71,356	1.69
January	177	1.75	176	1.27	353	1.51	46,333	1.46	20,397	1.36	66,730	1.43
February	3,651	3.13	2,680	2.36	6,331	2.80	34,803	1.62	20,971	1.32	55,774	1.51
March	2,109	3.21	648	2.91	2,757	3.14	15,061	1.49	1,156	1.49	16,217	1.49
April	10	3.50	6	2.00	16	2.94						
May	10	.70			10	.70	207	.37			207	.37
Total or average	6,108	$3.08	3,707	$2.32	9,815	$2.79	162,401	$1.65	95,136	$1.56	257,537	$1.61
1931-32												
November							23,923	$2.03	7,565	$1.75	31,488	$1.96
December	116	$1.57			116	$1.57	61,720	1.54	20,011	1.60	81,731	1.56
January	754	1.93			754	1.93	65,644	1.32	19,329	1.30	84,973	1.32
February	3,659	1.83	3,578	$2.07	7,237	1.95	47,878	1.64	6,873	1.52	54,751	1.62
March	3,705	2.16	517	2.15	4,222	2.16	7,623	1.83	226	1.42	7,849	1.82
April	2,955	2.47			2,955	2.47	679	1.75			679	1.75
May	95	1.04			95	1.04	159	1.11			159	1.11
Total or average	11,284	$2.10	4,095	$2.08	15,379	$2.10	207,626	$1.56	54,004	$1.50	261,630	$1.55
1932-33												
September-October							7	$1.86			7	$1.86
November							16,414	1.82	3,199	$1.31	19,613	1.73
December	103	$1.49			103	$1.49	31,738	1.31	13,375	1.31	45,113	1.31
January	1,807	1.88	182	$1.59	1,989	1.85	25,529	1.27	20,776	1.15	46,305	1.22
February	2,944	1.41	1,590	1.55	4,534	1.46	15,258	.97	12,245	1.19	27,503	1.07
March	3,448	1.83	3,803	1.33	7,251	1.57	17,827	1.13	14,478	1.09	32,305	1.11
April	4,757	1.34	2,010	1.30	6,767	1.33	4,169	1.00			4,169	1.00
Total or average	13,059	$1.56	7,585	$1.37	20,644	$1.49	110,942	$1.29	64,073	$1.19	175,015	$1.25

[1] Includes a small amount of Grade 3 fruit.

PERCENTAGE DISTRIBUTION OF ORANGES AND GRAPEFRUIT TO NEW YORK AND TO "OTHER MARKETS", BY GRADE

When comparing auction prices in New York with the "Other Markets", unless within the same grade and variety, attention is directed to Tables 10 and 11. For the three seasons New York received an average of 70.4 percent of the oranges sold in all markets compared with 95.1 percent of supergrade and 79.0 percent of grade 1 oranges. For the same period the New York

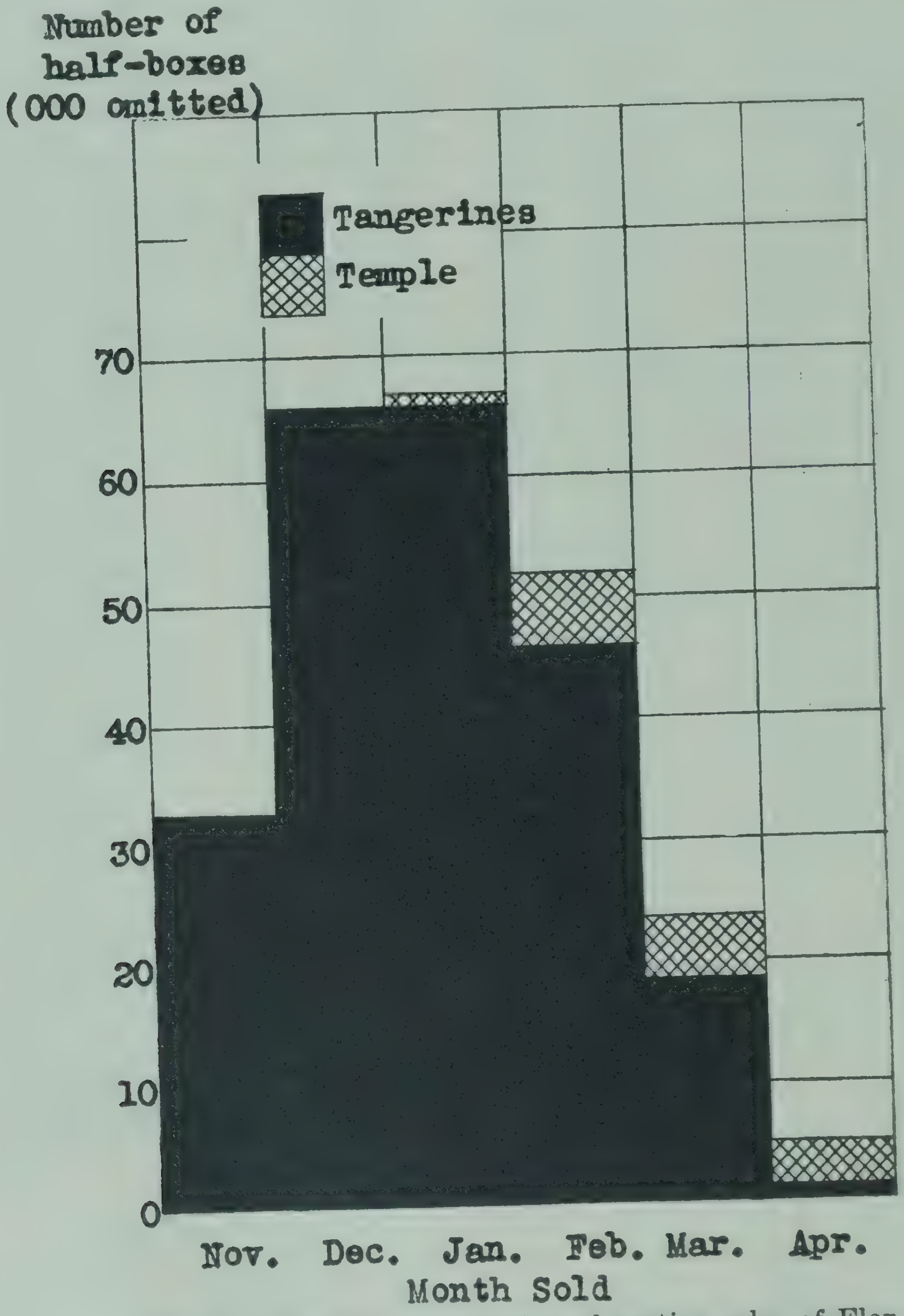

Fig. 19.—Seasonal distribution of auction sales of Florida mandarins from 31 packinghouses to five markets (average of three seasons, 1930-31, 1931-32, and 1932-33).

TABLE 10.—PERCENT OF FLORIDA CITRUS FRUITS FROM 31 PACKINGHOUSES WHICH SOLD AT AUCTION IN NEW YORK AND IN "OTHER MARKETS", BY GRADE.

Season	1930-31			1931-32			1932-33			Average 3 Seasons		
Kind of Fruit and Grade	New York	Other Markets	Total	New York	Other Markets	Total	New York	Other Markets	Total	New York	Other Markets	Total
Oranges:												
Supergrade	96.1	3.9	100.0	96.4	3.6	100.0	90.8	9.2	100.0	95.1	4.9	100.0
Grade 1	74.3	25.7	100.0	81.2	18.8	100.0	84.1	15.9	100.0	79.0	21.0	100.0
Grade 2	43.2	56.8	100.0	56.8	43.2	100.0	58.7	41.3	100.0	53.5	46.5	100.0
Grade 3	22.4	77.6	100.0	25.5	74.5	100.0	83.7	16.3	100.0	56.0	44.0	100.0
All grades ..	66.8	33.2	100.0	73.6	26.4	100.0	71.8	28.2	100.0	70.4	29.6	100.0
Grapefruit:												
Supergrade	89.2	10.8	100.0	89.2	10.8	100.0	82.1	17.9	100.0	88.1	11.9	100.0
Grade 1	66.0	34.0	100.0	72.4	27.6	100.0	64.8	35.2	100.0	67.9	32.1	100.0
Grade 2	29.2	70.8	100.0	58.2	41.8	100.0	56.1	43.9	100.0	46.9	53.1	100.0
Grade 3	5.6	94.4	100.0	18.8	81.2	100.0	30.1	69.9	100.0	21.1	78.9	100.0
All grades ..	53.6	46.4	100.0	67.1	32.9	100.0	59.6	40.4	100.0	59.4	40.6	100.0
Tangerines:												
Supergrade	80.2	19.8	100.0	75.4	24.6	100.0	82.7	17.3	100.0	79.2	20.8	100.0
Grade 1	72.7	27.3	100.0	83.3	16.7	100.0	72.4	27.6	100.0	76.7	23.3	100.0
Grade 2	26.0	74.0	100.0	70.2	29.8	100.0	48.2	51.8	100.0	50.0	50.0	100.0
Grade 3	100.0		100.0				46.6	53.4	100.0	49.8	50.2	100.0
All grades ..	63.1	36.9	100.0	79.4	20.6	100.0	63.4	36.6	100.0	69.3	30.7	100.0
Temples:												
Supergrade	93.9	6.1	100.0	73.6	26.4	100.0	100.0		100.0	86.9	13.1	100.0
Grade 1	58.3	41.7	100.0	67.4	32.6	100.0	87.9	12.1	100.0	73.1	26.9	100.0
Grade 2	62.0	38.0	100.0	75.8	24.2	100.0	50.5	49.5	100.0	59.7	40.3	100.0
Grade 3				100.0		100.0	25.5	74.5	100.0	58.0	42.0	100.0
All grades ..	62.2	37.8	100.0	73.4	26.6	100.0	63.3	36.7	100.0	66.4	33.6	100.0

TABLE 11.—PERCENTAGE DISTRIBUTION BY GRADE OF FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES, SOLD AT AUCTION IN NEW YORK AND IN "OTHER MARKETS".

Season	1930-31		1931-32		1932-33		Average 3 Seasons		
Kind of Fruit and Grade	New York	Other Markets	New York	Other Markets	New York	Other Markets	New York	Other Markets	All Markets
Oranges:									
Supergrade	11.4	.9	6.5	.7	4.4	1.1	7.6	.9	5.6
Grade 1	69.7	48.5	68.4	44.3	53.7	25.9	63.9	40.3	56.9
Grade 2	18.7	49.5	24.8	52.7	40.3	72.2	27.8	57.5	36.6
Grade 3	.2	1.1	.3	2.3	1.6	.8	.7	1.3	.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Grapefruit:									
Supergrade	6.9	1.0	5.0	1.3	2.7	.9	5.1	1.0	3.4
Grade 1	73.8	44.0	64.2	49.8	44.0	35.3	62.1	43.0	54.4
Grade 2	19.2	53.9	30.3	44.3	52.3	60.5	32.3	53.4	40.9
Grade 3	.1	1.1	.5	4.6	1.0	3.3	.5	2.6	1.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Tangerines:									
Supergrade	7.3	3.0	4.0	5.0	5.8	2.1	5.5	3.3	4.8
Grade 1	83.8	53.7	71.6	55.2	64.4	42.4	74.1	50.7	66.9
Grade 2	8.9	43.3	24.4	39.8	29.5	55.0	20.3	45.9	28.2
Grade 3	*				.3	.5	.1	.1	.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Temples:									
Supergrade	9.8	1.1	2.8	2.8	.8		3.3	1.0	2.6
Grade 1	47.3	55.6	48.2	64.0	54.0	12.8	50.5	36.8	45.9
Grade 2	42.9	43.3	37.6	33.2	42.0	70.8	40.6	54.1	45.1
Grade 3			11.4		3.2	16.4	5.6	8.1	6.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*Less than one-tenth of 1 percent.

auction received 59.4 percent of the grapefruit sold in the five markets, while the proportion of supergrade and grade 1 was 88.1 percent and 67.9 percent, respectively. Even though a majority of the oranges and grapefruit sold in the five markets went to New York, this auction received a still higher percentage of supergrade and grade 1 fruit, and a lower percentage of second and third grade fruit. For tangerines and Temples New York usually received a higher percent of each grade than "Other Markets"; also a higher proportion of high grade fruit.

PRICE RELATIVES OF GRADE 1 FLORIDA CITRUS FRUIT, USING THE PRICE OF GRADE 2 AS A BASE

Price relatives of grade 1 citrus fruit sold at auction, using the auction price of grade 2 as 100 percent, appear in Table 12. Although the actual price difference in grade 1 and grade 2 fruit is greater in oranges than in grapefruit, the percentage difference in the two grades is greater in grapefruit, because grapefruit usually brought the lower average price. Higher percentage premiums usually were paid for grade 1 fruit in New York than in "Other Markets" for both oranges and grapefruit.

TABLE 12.—PRICE RELATIVES OF GRADE 1 FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES, SOLD AT AUCTION, USING THE PRICE OF GRADE 2 FRUIT AS 100 PERCENT.

Season	1930-31		1931-32		1932-33	
Variety	New York	Other Markets	New York	Other Markets	New York	Other Markets
Oranges:						
Parson Brown	117	134	111	125	126	
Pineapple	112	118	113	108	129	108
Valencia	109	107	113	102	119	114
Other varieties	118	116	112	110	125	112
All varieties	111	111	114	103	127	114
Grapefruit:						
Marsh Seedless	150	124	113	121	142	131
Other varieties	125	120	122	114	139	137
All varieties	132	121	120	117	139	136
Mandarins:						
Temple	112	108	107	100	141	106
Tangerines	103	121	113	118	122	117

PERCENTAGE GRADE DISTRIBUTION OF FLORIDA CITRUS FRUIT BY VARIETIES

A percentage distribution, by variety and grade, of the total sales of Florida citrus by the 31 packinghouses on the five auctions is given in Table 13. Grades sold were lower in 1932-33

TABLE 13.—DISTRIBUTION OF FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES, SOLD AT AUCTION IN FIVE MARKETS, BY GRADE AND VARIETY.

Variety of Fruit	Supergrade		Grade 1		Grade 2		Grade 3		All Grades	
	Number of Boxes	Per-cent	Number of Boxes	Per-cent	Number of Boxes	Per-cent	Number of Boxes	Per-cent	Number of Boxes	Per-cent
1930-31										
Oranges:										
Parson Brown			19,284	70.9	7,906	29.1			27,190	100.0
Pineapple	28,739	16.2	104,127	58.8	44,262	25.0	87	*	177,215	100.0
Valencia	12,858	4.1	197,319	62.5	103,314	32.7	2,310	.7	315,801	100.0
Other varieties	18,564	7.9	153,014	65.0	62,919	26.7	1,015	.4	235,512	100.0
Total oranges	60,161	8.0	473,744	62.7	218,401	28.9	3,412	.4	755,718	100.0
Grapefruit:										
Marsh Seedless	6,530	3.8	98,886	57.1	66,519	38.4	1,166	.7	173,101	100.0
Other varieties	20,886	4.3	297,327	61.0	166,769	34.2	2,418	.5	487,400	100.0
Total grapefruit	27,416	4.2	396,213	60.0	233,288	35.3	3,584	.5	660,501	100.0
Mandarins:[1]										
King	149.5	7.6	920	46.5	908	45.9			1,977.5	100.0
Temple	320	6.5	2,473.5	50.4	2,114	43.1			4,907.5	100.0
Tangerines	7,352	5.7	93,597	72.7	27,800	21.6	19.5	*	128,768.5	100.0
Satsumas			417	44.2	423	44.9	103	10.9	943	100.0

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*Less than one-tenth of 1 percent.

[1] Converted to full boxes.

TABLE 13.—DISTRIBUTION OF FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES, SOLD AT AUCTION IN FIVE MARKETS, BY GRADE AND VARIETY *(Continued)*.

Variety of Fruit	Supergrade		Grade 1		Grade 2		Grade 3		All Grades	
	Number of Boxes	Per-cent	Number of Boxes	Per-cent	Number of Boxes	Per-cent	Number of Boxes	Per-cent	Number of Boxes	Per-cent
1931-32										
Oranges:										
Parson Brown	295	5.2	3,250	57.5	2,108	37.3			5,653	100.0
Pineapple	11,144	8.4	80,849	61.3	39,337	29.8	625	.5	131,955	100.0
Valencia	10,012	4.0	156,406	62.5	81,331	32.5	2,625	1.0	250,374	100.0
Other varieties	5,500	3.6	94,984	62.2	51,213	33.5	1,104	.7	152,801	100.0
Total oranges	26,951	5.0	335,489	62.0	173,989	32.2	4,354	.8	540,783	100.0
Grapefruit:										
Marsh Seedless	6,225	4.4	87,706	61.6	43,538	30.5	4,956	3.5	142,425	100.0
Other varieties	11,977	3.5	198,545	58.5	124,621	36.8	4,047	1.2	339,190	100.0
Total grapefruit	18,202	3.8	286,251	59.4	168,159	34.9	9,003	1.9	481,615	100.0
Mandarins:[1]										
King	114	4.0	1,178	41.1	1,485	51.9	87	3.0	2,864	100.0
Temple	216	2.8	4,029	52.4	2,800.5	36.4	644	8.4	7,689.5	100.0
Tangerines	5,513	4.2	89,226.5	68.2	36,075.5	27.6			130,815	100.0
Satsumas			39.5	25.6	74.5	48.2	40.5	26.2	154.5	100.0

[1] Converted to full boxes.

TABLE 13.—DISTRIBUTION OF FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES, SOLD AT AUCTION IN FIVE MARKETS, BY GRADE AND VARIETY *(Concluded)*.

Variety of Fruit	Supergrade		Grade 1		Grade 2		Grade 3		All Grades	
	Number of Boxes	Per-cent	Number of Boxes	Per-cent	Number of Boxes	Per-cent	Number of Boxes	Per-cent	Number of Boxes	Per-cent
					1932-33					
Oranges:										
Parson Brown	23	.4	3,354	56.5	2,151	36.2	409	6.9	5,937	100.0
Pineapple	13,597	7.7	102,973	57.9	60,325	33.9	827	.5	177,722	100.0
Valencia	6,540	2.5	84,165	32.3	163,722	62.8	6,312	2.4	260,739	100.0
Other varieties	2,339	1.2	105,015	52.4	91,754	45.7	1,395	.7	200,503	100.0
Total oranges	22,499	3.5	295,507	45.8	317,952	49.3	8,943	1.4	644,901	100.0
Grapefruit:										
Marsh Seedless	4,261	3.1	55,412	40.0	75,577	54.6	3,238	2.3	138,488	100.0
Other varieties	4,460	1.5	124,017	40.7	171,149	56.1	5,318	1.7	304,944	100.0
Total grapefruit	8,721	2.0	179,429	40.5	246,726	55.6	8,556	1.9	443,432	100.0
Mandarins:[1]										
King	75	6.2	593.5	49.2	479.5	39.8	57.5	4.8	1,205.5	100.0
Temple	49.5	.5	4,013	38.9	5,427	52.6	832.5	8.0	10,322	100.0
Tangerines	3,871	4.4	49,340.5	56.4	33,986	38.8	310	.4	87,507.5	100.0
Satsumas			87	61.3	55	38.7			142	100.0

[1] Converted to full boxes.

than in 1930-31 and 1931-32. Each variety contained a smaller percentage of supergrade and grade 1 fruit, and a larger percentage of grade 2 and grade 3 fruit than in the preceding two seasons.

The three-season average for all varieties of oranges was 5.6 percent supergrade, 56.9 percent grade 1, 36.6 percent grade 2, and 0.9 percent grade 3. For all varieties of grapefruit, the three-season average was 3.4 percent supergrade, 54.4 percent grade 1, 40.9 percent grade 2 and 1.3 percent grade 3.

SIZE DISTRIBUTION, BY VARIETY, AND SEASON AVERAGE PRICE FOR EACH SIZE

The season average auction price of Florida citrus sold by the 31 packinghouses for each variety, by size, together with the percentage size distribution are shown in Tables 14, 15, and 16.

The highest price received for all varieties or oranges combined was for size 200 in 1931-32 and 1932-33. In 1930-31 a slightly higher average price was paid for size 176, though there was little difference that season in the average price for sizes 150, 176, and 200. The three-season average price was highest for size 176 (Fig. 20). The average size of oranges in 1930-31 was 201; in 1931-32 it was 220; and in 1932-33, 219.

The difference in average prices paid on the auctions between the most desirable and the least desirable sizes was 56 cents per box in 1930-31, 99 cents in 1931-32, and 90 cents in 1932-33. "Other Sizes" have been omitted from this calculation because it consists of a mixture of sizes. However, in 1930-31 and 1931-32 "Other Sizes" brought the lowest price of all oranges, but in 1932-33 size 100 brought a slightly lower price.

The highest price for Parson Browns was paid for size 150 in 1930-31, 176 in 1931-32, and 200 in 1932-33. For Pineapple oranges the premium was paid for size 126 in 1930-31, 150 in 1931-32, and 176 in 1932-33. In 1930-31 the Valencias sold ran heavily to the larger sizes and the highest price was paid for a comparatively small size, 250. In 1931-32 and 1932-33 the Valencias averaged smaller and size 200 received the highest price both seasons (Figs. 21, 22, and 23).

It should be understood that the price lines in Figs. 21, 22, and 23 are on the basis of a season price for each variety and size. Because of differences in the seasonal distribution of varieties, as already pointed out, the price comparisons should be

TABLE 14.—FLORIDA ORANGES—SEASON AVERAGE AUCTION PRICES PER BOX FROM 31 PACKINGHOUSES IN FIVE MARKETS, BY VARIETY AND SIZE.

Size	Parson Brown						Pineapple						Valencia					
	1930-31		1931-32		1932-33		1930-31		1931-32		1932-33		1930-31		1931-32		1932-33	
	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price
100	*	$4.00	*	$2.00	.1	$2.25	.1	$3.60	.1	$3.43	.2	$2.22	1.2	$2.96	.6	$2.98	1.2	$1.84
126	.3	4.72	.9	3.13	2.5	2.67	2.0	4.06	1.9	3.77	2.1	3.07	10.7	3.33	6.0	3.28	8.4	2.12
150	2.6	5.00	3.6	3.45	7.6	3.03	6.7	4.03	4.8	4.03	5.5	3.30	19.6	3.61	11.4	3.63	12.8	2.36
176	11.5	4.56	12.1	3.65	13.8	3.34	18.8	3.69	11.9	3.98	12.0	3.35	25.4	3.91	18.2	3.87	17.2	2.51
200	12.9	3.98	11.9	3.30	14.4	3.44	19.0	3.44	12.5	3.85	13.5	3.28	15.5	4.12	14.3	4.02	13.9	2.58
216	26.2	3.72	26.7	3.03	18.8	3.30	24.2	3.31	20.8	3.53	21.4	2.92	14.1	4.14	18.3	3.93	16.1	2.44
250	23.6	3.68	27.2	2.80	24.9	3.20	20.1	3.42	25.0	3.29	23.8	2.70	8.9	4.24	15.9	3.92	15.2	2.38
288	17.3	3.34	14.9	2.47	13.6	3.01	7.0	3.40	16.7	3.03	14.4	2.50	3.4	3.90	9.8	3.59	9.2	2.23
324	4.9	2.83	2.5	1.71	3.3	2.74	1.8	3.11	5.7	2.76	5.9	2.23	.9	3.62	4.5	3.10	4.6	2.08
Other	.7	2.51	.2	2.64	1.0	2.33	.3	3.03	.6	2.68	1.2	2.05	.3	3.40	1.0	2.89	1.4	1.93
All sizes	100.0	$3.76	100.0	$2.97	100.0	$3.20	100.0	$3.50	100.0	$3.46	100.0	$2.88	100.0	$3.87	100.0	$3.77	100.0	$2.37
Number of boxes sold	27,190		5,653		5,937		177,215		131,955		177,722		315,801		250,374		260,739	

Sizes	Other Varieties						All Varieties					
	1930-31		1931-32		1932-33		1930-31		1931-32		1932-33	
	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price
100	.5	$3.65	.7	$2.67	.3	$2.03	.7	$3.13	.5	$2.89	.7	$1.91
126	3.2	3.43	3.4	3.06	2.6	2.33	5.9	3.41	4.2	3.28	4.8	2.27
150	8.1	3.35	6.4	3.40	5.5	2.55	12.4	3.62	8.3	3.64	8.5	2.57
176	19.9	3.26	12.8	3.52	11.5	2.66	21.6	3.69	15.1	3.80	13.9	2.75
200	18.0	3.23	12.9	3.46	12.0	2.67	17.0	3.64	13.4	3.82	13.2	2.81
216	23.6	3.15	19.8	3.31	21.2	2.45	19.9	3.52	19.4	3.63	19.2	2.60
250	17.9	3.27	22.8	3.12	23.1	2.39	14.9	3.59	20.2	3.46	20.1	2.50
288	6.5	3.14	15.2	2.90	14.5	2.30	5.7	3.42	13.1	3.17	12.3	2.35
324	1.9	2.97	5.6	2.55	6.9	2.12	1.6	3.15	5.1	2.83	5.6	2.14
Other	.4	2.98	.4	2.58	2.4	1.96	.3	3.10	.7	2.80	1.7	1.97
All sizes	100.0	$3.23	100.0	$3.20	100.0	$2.43	100.0	$3.58	100.0	$3.52	100.0	$2.54
Number of boxes sold	235,512		152,795		200,503		755,718		540,777		644,901	

*Less than one-tenth of 1 percent.

TABLE 15.—FLORIDA GRAPEFRUIT—SEASON AVERAGE AUCTION PRICES PER BOX FROM 31 PACKINGHOUSES IN FIVE MARKETS, BY VARIETY AND SIZE.

Size	Marsh Seedless						Other Varieties						All Varieties					
	1930-31		1931-32		1932-33		1930-31		1931-32		1932-33		1930-31		1931-32		1932-33	
	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price
36	1.1	$2.93	.7	$3.53	1.2	$2.92	2.6	$2.78	3.1	$2.59	1.2	$2.93	2.2	$2.80	2.4	$2.67	1.2	$2.93
46	7.2	2.95	3.5	3.88	5.1	3.04	11.8	2.93	8.2	2.94	5.6	2.90	10.6	2.94	6.9	3.09	5.4	2.94
54	24.4	2.66	12.9	3.39	14.3	2.69	29.2	2.72	20.6	2.70	19.3	2.43	28.0	2.70	18.3	2.84	17.8	2.49
64	22.8	2.71	16.6	3.13	15.0	2.65	22.1	2.76	20.7	2.47	19.4	2.35	22.2	2.75	19.5	2.64	18.0	2.43
70	18.9	2.84	20.3	3.10	16.8	2.69	16.9	2.88	19.0	2.42	19.0	2.36	17.4	2.87	19.4	2.63	18.4	2.45
80	17.1	2.85	24.9	3.03	24.7	2.51	12.8	2.99	19.4	2.32	24.0	2.29	14.0	2.95	21.0	2.57	24.2	2.36
96	7.4	2.77	16.9	2.92	18.6	2.18	4.2	2.89	7.8	2.18	9.9	2.21	5.0	2.84	10.5	2.53	12.6	2.20
100	.1	2.51	.3	2.49	.4	2.07	.1	2.52	.2	2.46	.1	1.99	.1	2.51	.2	2.47	.2	2.03
126	.9	2.42	3.5	2.55	3.3	1.80	.3	2.46	.5	1.89	.7	2.00	.5	2.44	1.3	2.39	1.5	1.86
Other	.1	2.26	.4	2.30	.6	1.97	*	2.48	.5	2.14	.8	1.79	*	2.39	.5	2.18	.7	1.83
All sizes	100.0	$2.77	100.0	$3.10	100.0	$2.53	100.0	$2.82	100.0	$2.49	100.0	$2.37	100.0	$2.81	100.0	$2.67	100.0	$2.42
Number of boxes sold	173,101		142,425		138,488		487,400		339,190		304,944		660,501		481,615		443,432	

*Less than one-tenth of 1 percent.

made only between different sizes of the same variety, and not between varieties.

The average size of grapefruit in 1930-31 was 64; in 1931-32, 69; and in 1932-33, 71. More than 95 percent of the fruit sold was in sizes 46 to 96, inclusive (Table 15).

In 1930-31 the premium was paid for sizes slightly smaller than the average of all grapefruit, except for the largest two sizes, 36 and 46, which brought prices about average or above, for all sizes. In 1931-32 and 1932-33 sizes larger than average received prices above average for all sizes.

The highest average auction price for grapefruit in 1930-31 was received for size 80, though this was only 1 cent above the average for size 46, for which the highest average price was paid in 1931-32 and 1932-33. The amount of fruit in this latter size was comparatively small, ranging from 5.4 percent of the total in 1932-33 to 10.6 percent in 1930-31. The three-season average price was highest for size 46 (Fig. 24).

Size 46 Marsh Seedless brought the highest price each of the seasons for that variety; for "Other Varieties" of grapefruit

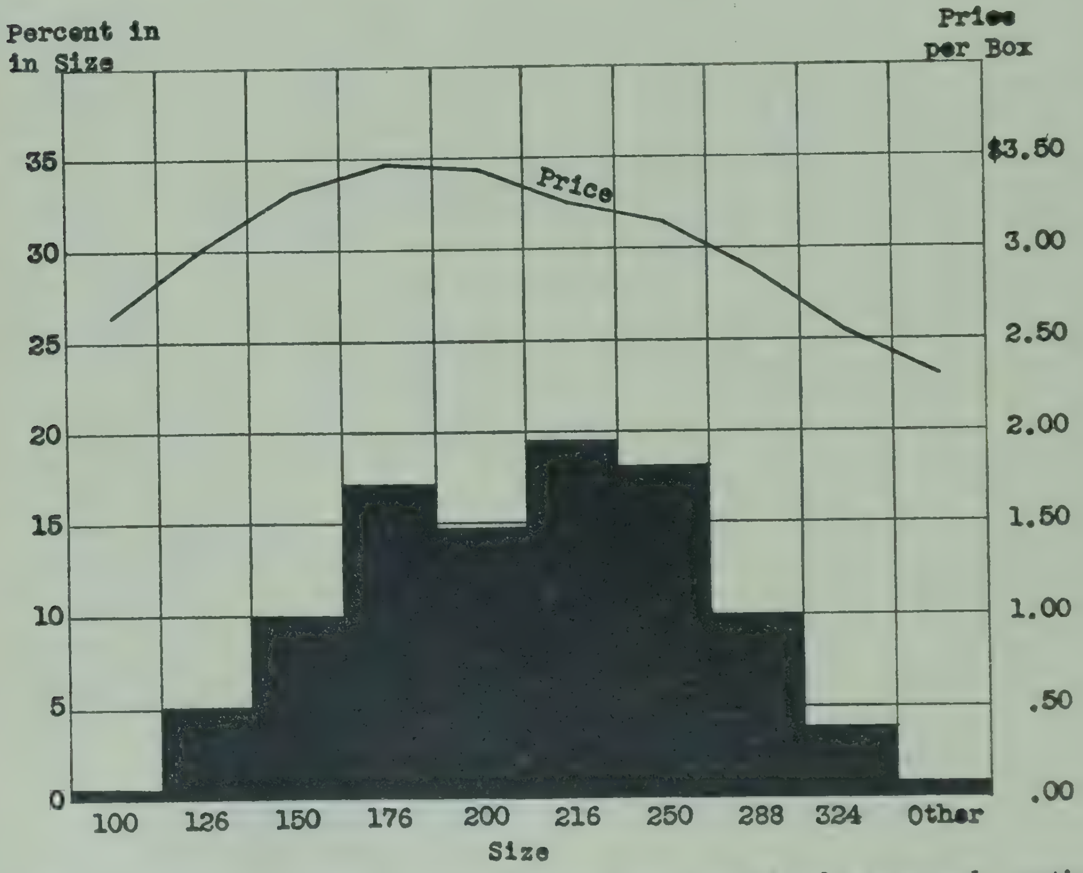

Fig. 20.—Percentage size distribution and weighted averaged auction prices of Florida oranges in five markets (average of three seasons, 1930-31, 1931-32, and 1932-33).

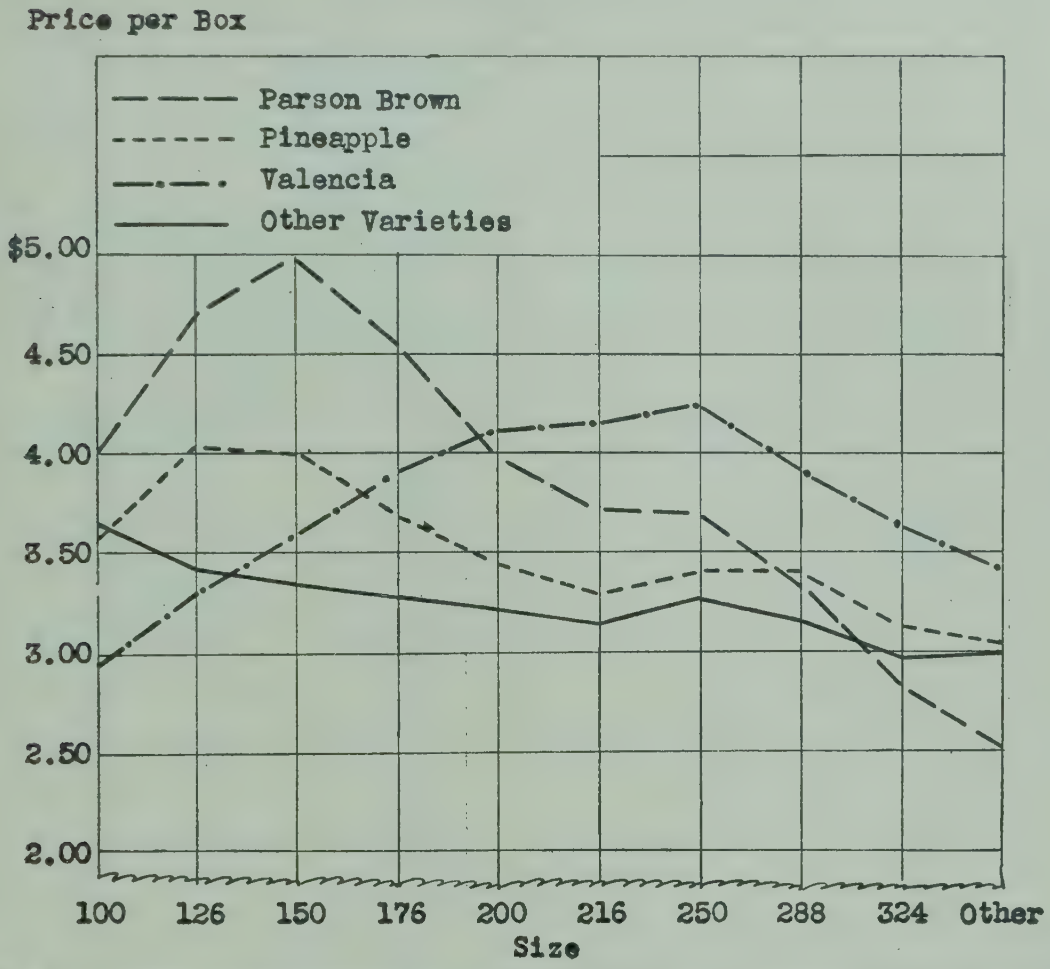

Fig. 21.—Season average auction prices of Florida oranges in five markets, by variety and size, 1930-31.

size 80 was highest in 1930-31, size 46 in 1931-32, and size 36 in 1932-33 (Figs. 25, 26, and 27).

Between the most desirable and the least desirable sizes of grapefruit, excluding "Other Sizes", a difference of 51 cents per box was received on the auctions in 1930-31, 70 cents in 1931-32, and $1.08 in 1932-33. The lowest price each season was for the smallest individual size. If these price comparisons are made within varieties it will be found that in Marsh Seedless grapefruit even larger differences existed each season between the most desirable and least desirable sizes.

The highest average price received on the auctions for tangerines was for size 90 in 1930-31 and 1931-32 and for size 120 in 1932-33 (Table 16). Sizes larger than 120 contained a negligible amount of fruit, the bulk of that sent to auction falling in sizes 144 to 216, inclusive. There was no great price differential between these four sizes, the most desirable bringing 18 cents per half-box more than the least desirable size in 1930-31, 2 cents more in 1931-32, and 21 cents more in 1932-33 (Fig. 28).

TABLE 16.—FLORIDA MANDARINS—SEASON AVERAGE AUCTION PRICES PER HALF-BOX FROM 31 PACKINGHOUSES IN FIVE MARKETS, BY VARIETY AND SIZE.

Size	King						Temple					
	1930-31		1931-32		1932-33		1930-31		1931-32		1932-33	
	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price
90	17.9	$2.61	22.7	$1.81	20.3	$1.51	30.9	$2.86	24.3	$2.14	24.4	$1.55
106	8.3	2.54	11.6	1.76	11.1	1.54	17.3	2.93	22.7	2.20	25.9	1.61
120	5.3	2.35	7.0	1.71	6.5	1.41	8.8	2.75	16.9	2.15	15.5	1.58
144	2.7	2.25	3.6	1.71	2.7	1.38	1.8	2.50	6.0	1.89	5.1	1.50
168	.7	2.36	1.1	1.47	1.2	1.07	.3	1.97	3.6	1.72	1.4	1.29
196			.2	1.79	.6	1.07	.1	1.00	2.2	1.84	1.2	1.07
216			.2	1.73			*	1.00	.9	2.99	1.3	.89
224					.6	1.13			1.1	1.94	.1	1.07
250			.1	1.43	.3	1.00			.5	1.68	1.1	.82
Other	65.1	2.36	53.5	1.69	56.7	1.28	40.8	2.71	21.8	2.04	24.0	1.35
All sizes	100.0	$2.42	100.0	$1.73	100.0	$1.36	100.0	$2.79	100.0	$2.10	100.0	$1.49
Number of half-boxes sold	3,955		5,728		2,411		9,815		15,379		20,644	

Size	Tangerines						Satsumas					
	1930-31		1931-32		1932-33		1930-31		1931-32		1932-33	
	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price
90	.2	$1.97	.2	$1.81	.3	$1.19	1.5	$1.18			.4	$2.00
106	.8	1.68	.7	1.43	.6	1.26	4.2	1.16	.7	$ .50	3.5	1.40
120	5.9	1.64	4.9	1.49	3.0	1.48	14.0	1.67	7.1	1.18	10.2	1.38
144	21.6	1.71	17.1	1.57	10.2	1.43	24.2	2.15	22.3	1.45	25.7	1.10
168	31.0	1.65	29.2	1.56	20.3	1.33	25.3	2.30	27.8	1.24	28.9	1.04
196	19.1	1.60	22.0	1.56	19.9	1.27	18.1	2.35	19.8	.97	19.0	1.09
216	13.1	1.53	14.0	1.55	17.9	1.22	6.1	2.62	7.1	1.36	8.4	.96
224	.7	1.38	3.1	1.54	6.4	1.19	.8	1.80	10.4	.72	.4	1.00
250	6.4	1.35	7.4	1.50	14.7	1.12	4.6	2.24	4.5	.71	3.5	1.10
Other	1.2	1.49	1.4	1.42	6.7	1.02	1.2	1.95	.3	.00		
All sizes	100.0	$1.61	100.0	$1.55	100.0	$1.25	100.0	$2.13	100.0	$1.15	100.0	$1.11
Number of half-boxes sold	257,537		261,630		175,015		1,886		309		284	

*Less than one-tenth of 1 percent.

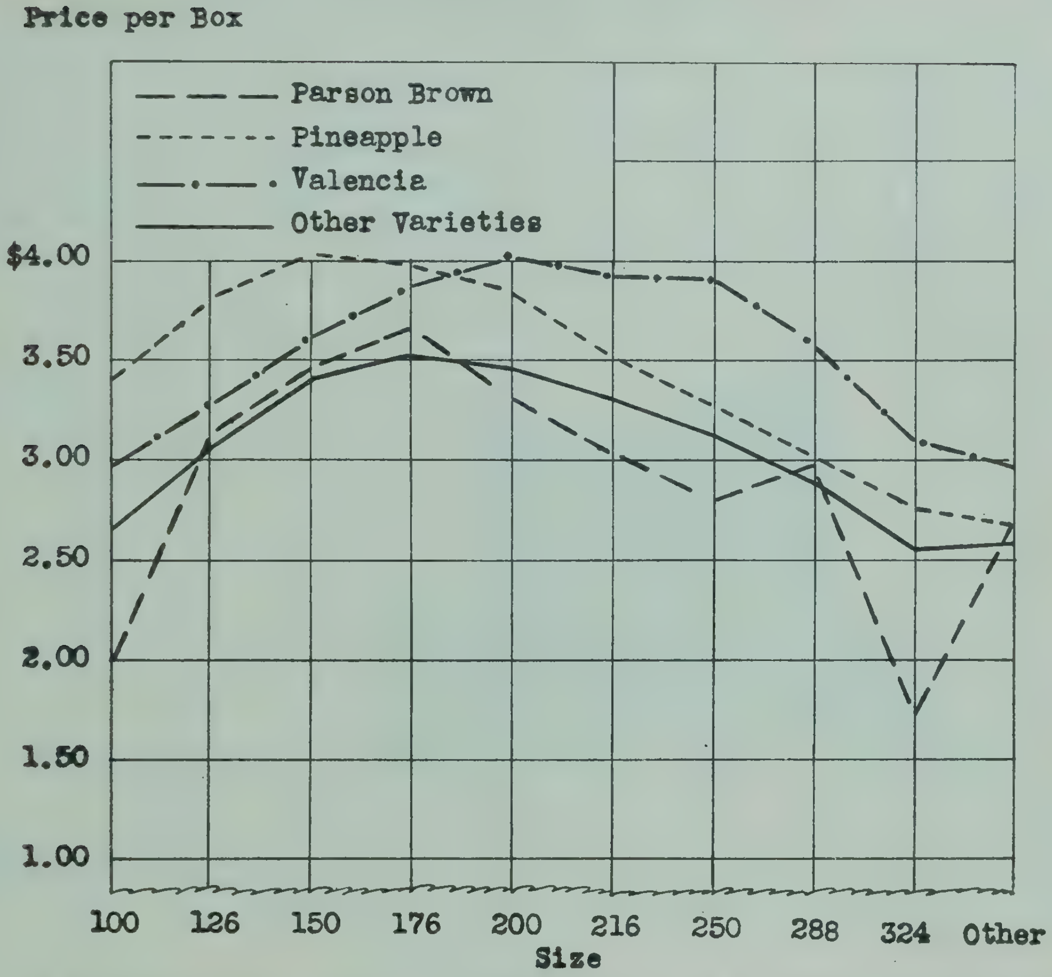

Fig. 22.—Season average auction prices of Florida oranges in five markets, by variety and size, 1931-32.

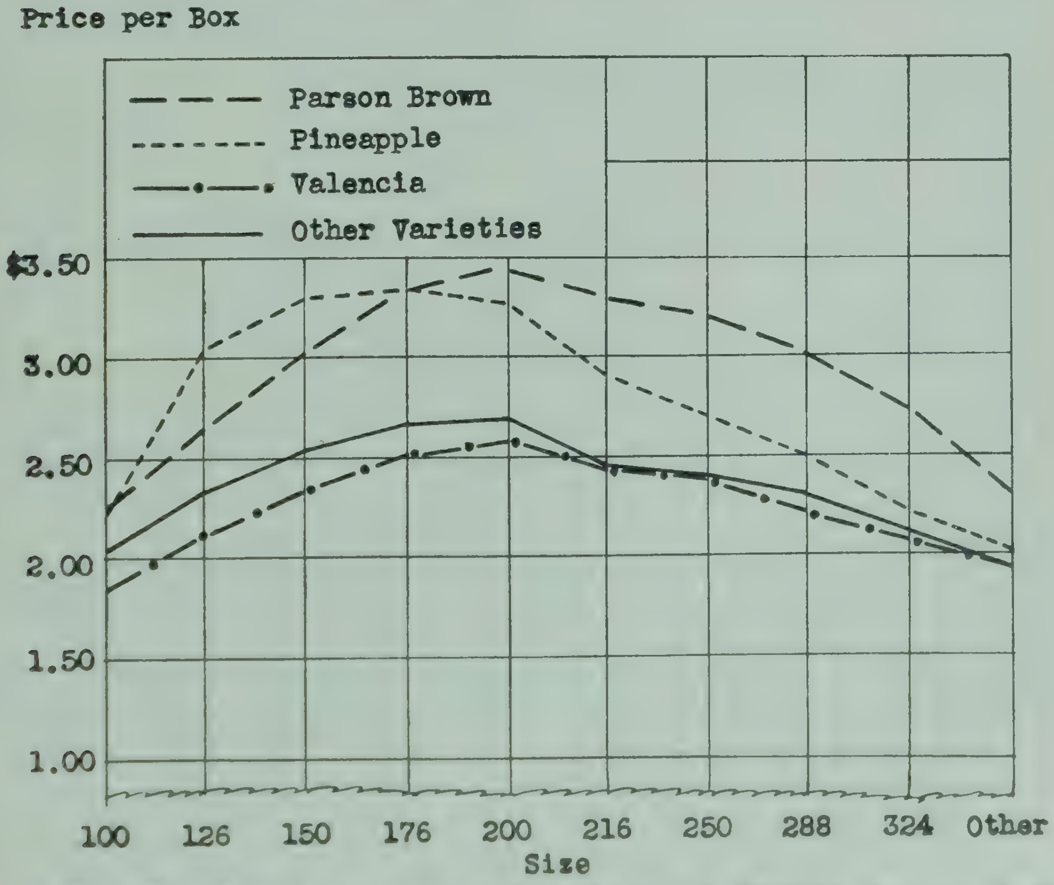

Fig. 23.—Season average auction prices of Florida oranges in five markets, by variety and size, 1932-33.

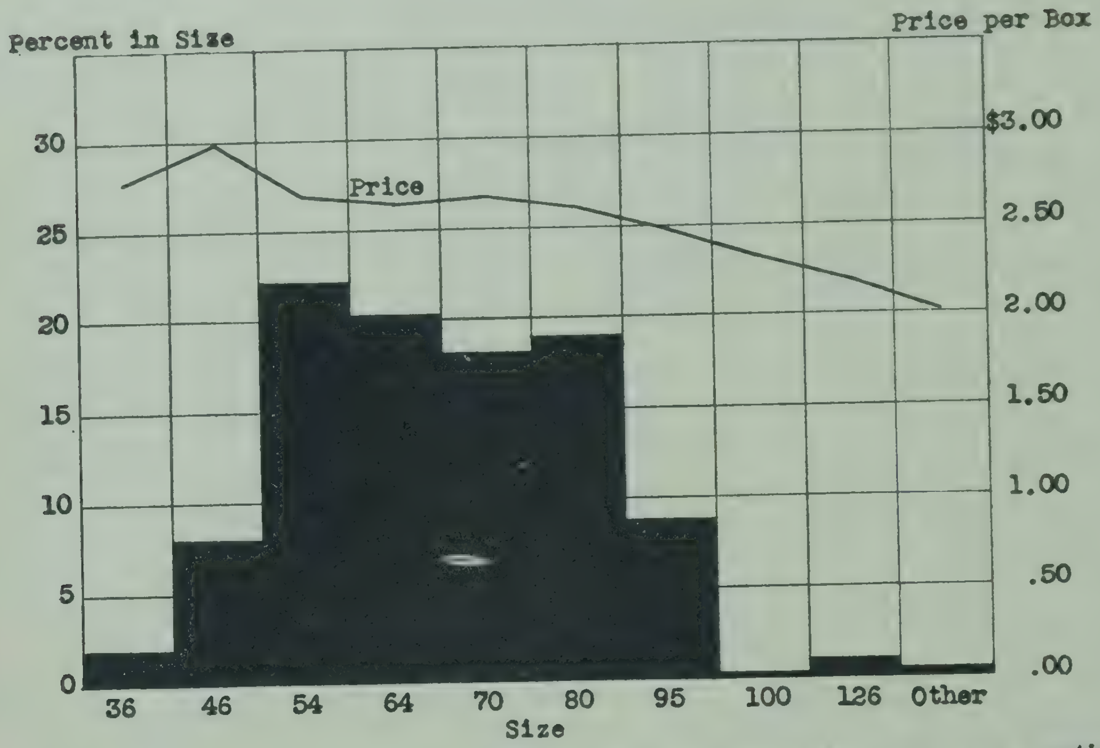

Fig. 24.—Percentage size distribution and weighted average auction prices of Florida grapefruit in five markets (average of three seasons, 1930-31, 1931-32, and 1932-33).

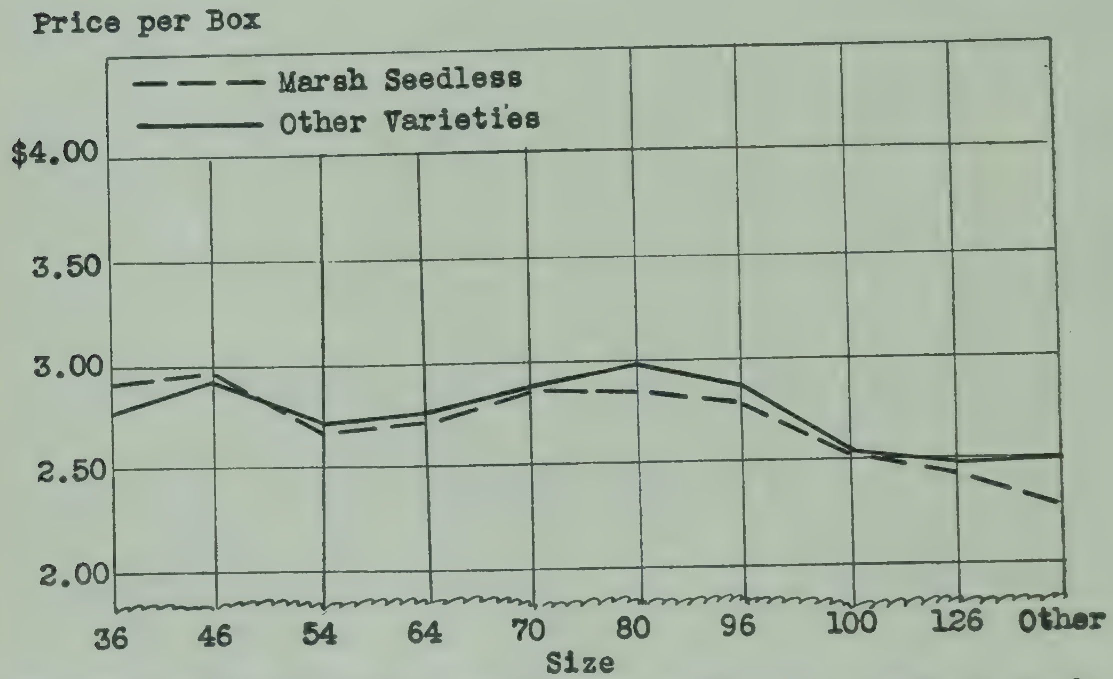

Fig. 25.—Season average auction prices of Florida grapefruit in five markets, by variety and size, 1930-31.

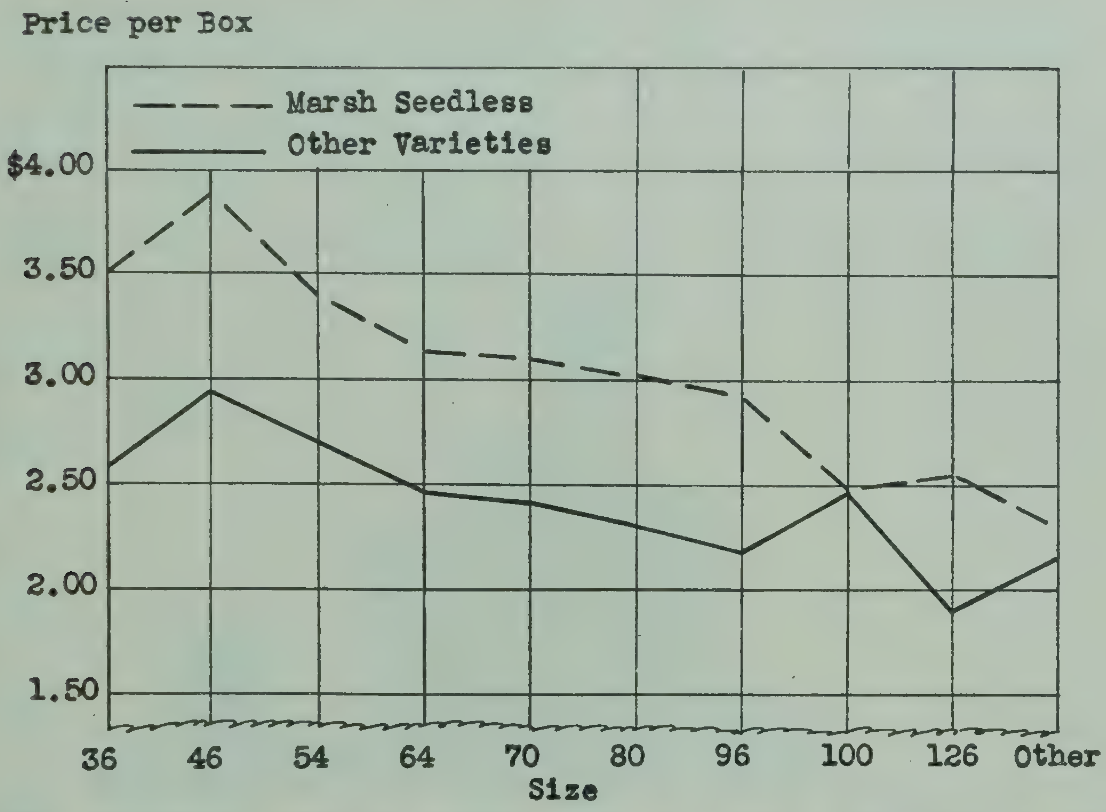

Fig. 26.—Season average auction prices of Florida grapefruit in five markets, by variety and size, 1931-32.

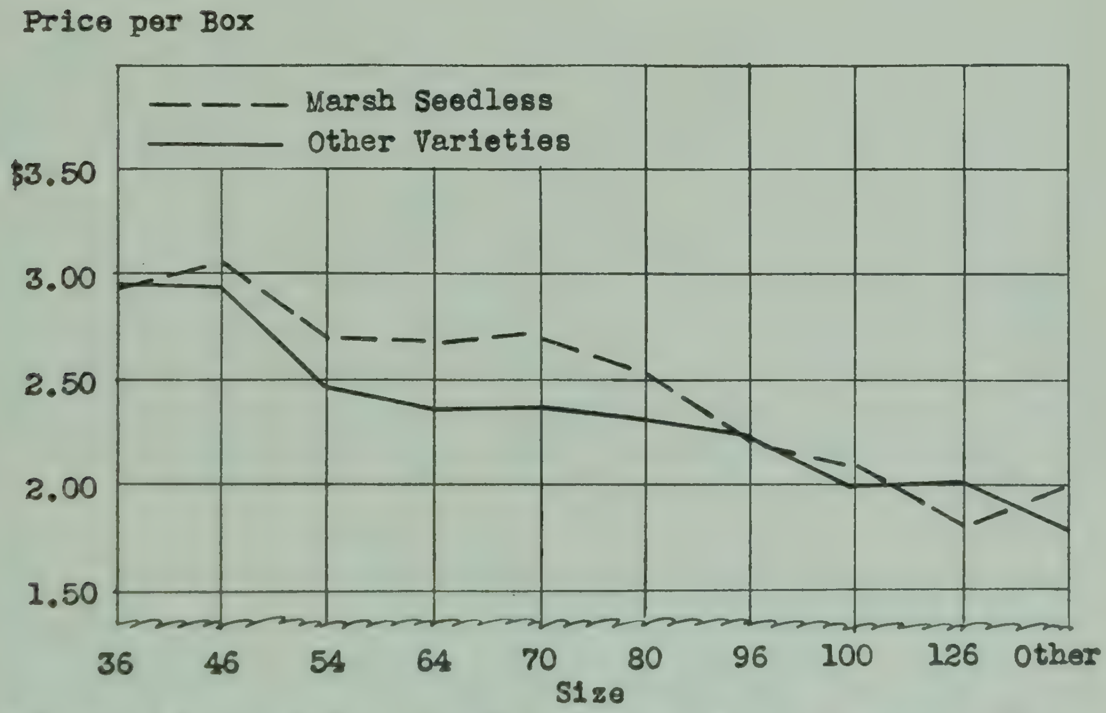

Fig. 27.—Season average auction prices of Florida grapefruit in five markets, by variety and size, 1932-33.

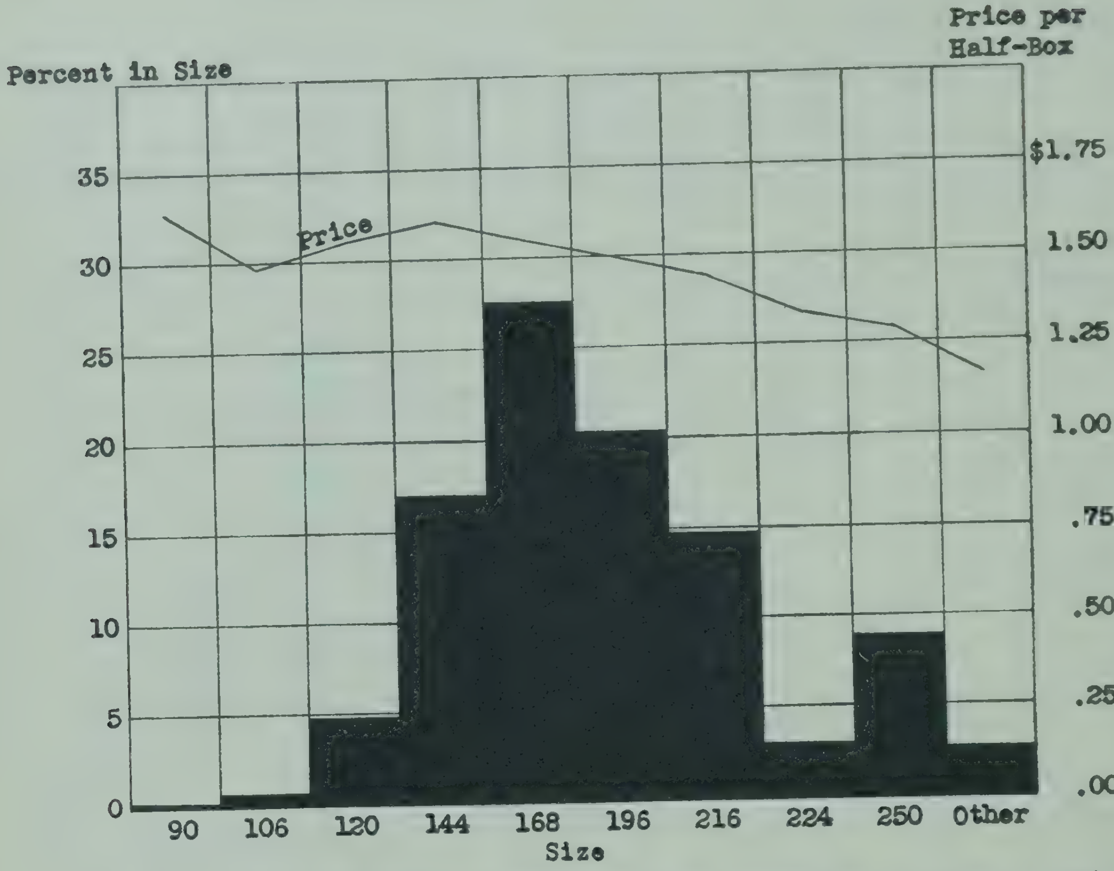

Fig. 28.—Percentage size distribution and weighted average auction prices of Florida tangerines in five markets (average of three seasons, 1930-31, 1931-32, and 1932-33).

COSTS OF MARKETING FLORIDA CITRUS FRUIT AT AUCTION

A comparison of the monthly average costs of marketing Florida citrus fruit from 31 packinghouses at auction in New York City with the costs in the "Other Markets" is shown in Table 17. The number of boxes of fruit sold includes oranges, grapefruit, Temples, tangerines and a few minor kinds or varieties for which no prices are given. All containers have been converted to the equivalent number of standard full boxes. This was the usual container in which oranges and grapefruit were packed, but Temples and tangerines were most frequently packed in half-boxes or bushel baskets.

Freight includes the regular transportation charge made by the railroad, steamship company, or truck, plus a few other minor charges when they occurred, such as emergency charge, back haul, switching charge, and dock labor. All routes of shipment have been combined in arriving at the average freight charge. However, only New York received fruit by water routes, as all citrus shipped to "Other Markets" moved by rail. Variations in monthly freight charge are due mainly to variations in distance from the origin points to market, and in route of shipment, although there were some changes in the rail rate structure.[1]

The average cost per box for freight to New York decreased materially from the beginning of the 1930-31 season to the end of the 1932-33 season. This is in part accounted for by the increased use of water transportation on which the rate was lower than for rail transportation. In 1930-31 shipments from the 31 packinghouses to New York by water were relatively unimportant, but by the end of 1932-33 routes involving water transportation carried more than one-half the volume.

Preservation as used in this text includes the cost of pre-cooling and the cost of refrigeration in transit by various means. The cost per box is the average for all boxes shipped, and not merely for those which were pre-cooled or refrigerated in transit. This cost would have been higher had all the fruit shipped received some kind of preservation treatment.

The auction selling charge is based on a percentage of the sales value of the fruit, and since all varieties of citrus are included, the monthly average cost per box will be affected by variations in the price paid for different varieties of fruit, and changes in the relative proportions of these varieties. Since oranges usually brought a higher price than grapefruit, the selling cost for them would be slightly higher, and the selling cost for grapefruit slightly lower than the average selling charge shown.

"Other Charges" include a large number of incidental and unusual expenses which are not very important except in a few cases. Among these charges are Government inspection, reconsigning, demurrage, cataloging, storage, drayage, recoopering damaged boxes, and heaters in extreme weather. Storage was by far the largest of these charges and for a few cars was very heavy. It will be noted that most of these "Other Charges"

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[1] On January 4, 1932, an emergency charge of 1 cent per 100 pounds was added to the rail rate on citrus, and expired September 30, 1933. On February 22, 1932, temporary reductions were made in the rates to Washington, Baltimore, Philadelphia, Trenton, New York and neightboring cities taking the same rate. These rates did not apply from points on the Florida East Coast Railroad until March 2, when this railroad concurred in the reduction which lasted until June 15, 1932.

Some reduction in rates to Eastern cities was again made effective on April 1, 1933, to expire June 30, 1933. (From the Florida Agricultural Extension Economist, Vol. III, No. 5. The Florida Agricultural Extension Service, Gainesville, Florida.)

TABLE 17.—COSTS OF MARKETING FLORIDA CITRUS FRUIT AT AUCTION, FROM 31 PACKINGHOUSES TO FIVE MARKETS.

Month Sold	New York						Other Markets						All Markets					
	Number of Boxes	Cost per Box					Number of Boxes	Cost per Box					Number of Boxes	Cost per Box				
		Fr'ght	Preservation	Auction Selling	Other	Total		Fr'ght	Preservation	Auction Selling	Other	Total		Fr'ght	Preservation	Auction Selling	Other	Total
										1930-31								
September-October	41,981	$0.954	$0.173	$0.083	*	$1.210	32,152	$0.990	$0.186	$0.068	$0.003	$1.247	74,133	$0.970	$0.179	$0.076	$0.001	$1.226
November	102,264	.946	.134	.065	$0.002	1.147	73,120	.977	.158	.060	.004	1.199	175,384	.959	.143	.063	.003	1.168
December	103,757	.941	.125	.058	*	1.124	76,478	.978	.104	.055	.005	1.142	180,235	.957	.117	.056	.002	1.132
January	127,216	.951	.076	.053	*	1.080	85,569	.980	.064	.053	.003	1.100	212,785	.963	.071	.053	.001	1.088
February	113,345	.955	.074	.057	.002	1.088	74,390	.942	.056	.056	.004	1.058	187,735	.950	.067	.056	.003	1.076
March	122,154	.953	.084	.062	.002	1.101	54,866	.987	.042	.060	.007	1.096	177,020	.964	.071	.061	.003	1.099
April	103,871	.956	.085	.062	.004	1.107	59,413	.983	.065	.060	.005	1.113	163,284	.966	.077	.062	.005	1.110
May	138,923	.947	.135	.060	.026	1.168	94,332	.978	.158	.063	.015	1.214	233,255	.960	.144	.061	.022	1.187
June	83,040	.966	.193	.058	.072	1.289	56,256	.983	.206	.056	.049	1.294	139,296	.972	.198	.058	.063	1.291
July-August	7,435	.960	.170	.049	.079	1.258	1,535	1.008	.215	.036	.096	1.355	8,970	.968	.178	.047	.082	1.275
Total or average	943,986	$0.952	$0.113	$0.060	$0.012	$1.137	608,111	$0.976	$0.112	$0.058	$0.011	$1.157	1,552,097	$0.961	$0.112	$0.060	$0.012	$1.145
										1931-32								
September-October	14,247	$0.975	$0.141	$0.060		$1.176	18,935	$0.959	$0.193	$0.057	$0.001	$1.210	33,182	$0.966	$0.171	$0.058	$0.001	$1.196
November	68,712	.927	.070	.061	$0.001	1.059	37,916	.970	.085	.055	.003	1.113	106,628	.942	.076	.059	.001	1.078
December	127,975	.916	.079	.055	.001	1.051	44,238	.974	.074	.054	.002	1.104	172,213	.931	.077	.055	.001	1.064
January	132,767	.916	.085	.052	*	1.053	51,978	.980	.103	.052	.003	1.138	184,745	.934	.090	.052	.001	1.077
February	143,281	.896	.090	.055	*	1.041	44,981	.980	.127	.056	.003	1.166	188,262	.916	.098	.056	.001	1.071
March	126,102	.770	.051	.060	.001	.882	40,601	.976	.038	.060	.003	1.077	166,703	.820	.049	.060	.001	.930
April	89,168	.773	.065	.064	.006	.908	47,534	.987	.072	.068	.002	1.129	136,702	.847	.068	.065	.005	.985
May	88,299	.764	.101	.066	.028	.959	42,156	.991	.156	.070	.002	1.219	130,455	.837	.119	.067	.020	1.043
June	43,548	.782	.138	.067	.041	1.028	6,005	.952	.183	.057	.002	1.194	49,553	.803	.144	.065	.037	1.049
July-August	1,706	.884	.080	.068		1.032							1,706	.884	.080	.068		1.032
Total or average	835,805	$0.854	$0.082	$0.059	$0.006	$1.001	334,344	$0.978	$0.102	$0.059	$0.002	$1.141	1,170,149	$0.889	$0.088	$0.059	$0.005	$1.041
										1932-33								
September-October	8,573	$0.957	$0.142	$0.067		$1.166	8,673	$0.999	$0.203	$0.070	$0.003	$1.275	17,246	$0.979	$0.172	$0.068	$0.002	$1.221
November	62,363	.906	.098	.062	$0.001	1.067	23,768	.985	.136	.059	.002	1.182	86,131	.928	.109	.061	.001	1.099
December	125,965	.895	.076	.051	*	1.022	43,276	.981	.101	.054	.002	1.138	169,241	.917	.082	.052	.001	1.052
January	92,939	.857	.071	.048	*	.976	44,488	.979	.113	.052	.003	1.147	137,427	.896	.085	.049	.001	1.031
February	95,949	.771	.038	.042	.008	.859	44,220	.984	.090	.051	.003	1.128	140,169	.838	.055	.045	.006	.944
March	138,355	.770	.038	.041	*	.849	54,517	1.006	.084	.047	.005	1.142	192,872	.837	.050	.043	.002	.932
April	117,562	.741	.040	.040	*	.821	50,550	.972	.117	.047	.004	1.140	168,112	.811	.063	.042	.001	.917
May	108,630	.728	.048	.037	*	.813	64,556	.975	.142	.045	.002	1.164	168,186	.823	.084	.040	.001	.948
June	57,738	.704	.051	.040	*	.795	20,713	.966	.176	.049	.001	1.192	78,451	.774	.084	.042	*	.900
July-August	80,603	.665	.056	.038	.003	.762	8,446	.997	.217	.045	.001	1.260	34,049	.699	.072	.039	.003	.813
Total or average	833,677	$0.793	$0.056	$0.045	$0.001	$0.895	358,207	$0.982	$0.119	$0.050	$0.003	$1.154	1,191,884	$0.850	$0.075	$0.046	$0.002	$0.973

*Less than one-tenth of 1 cent.

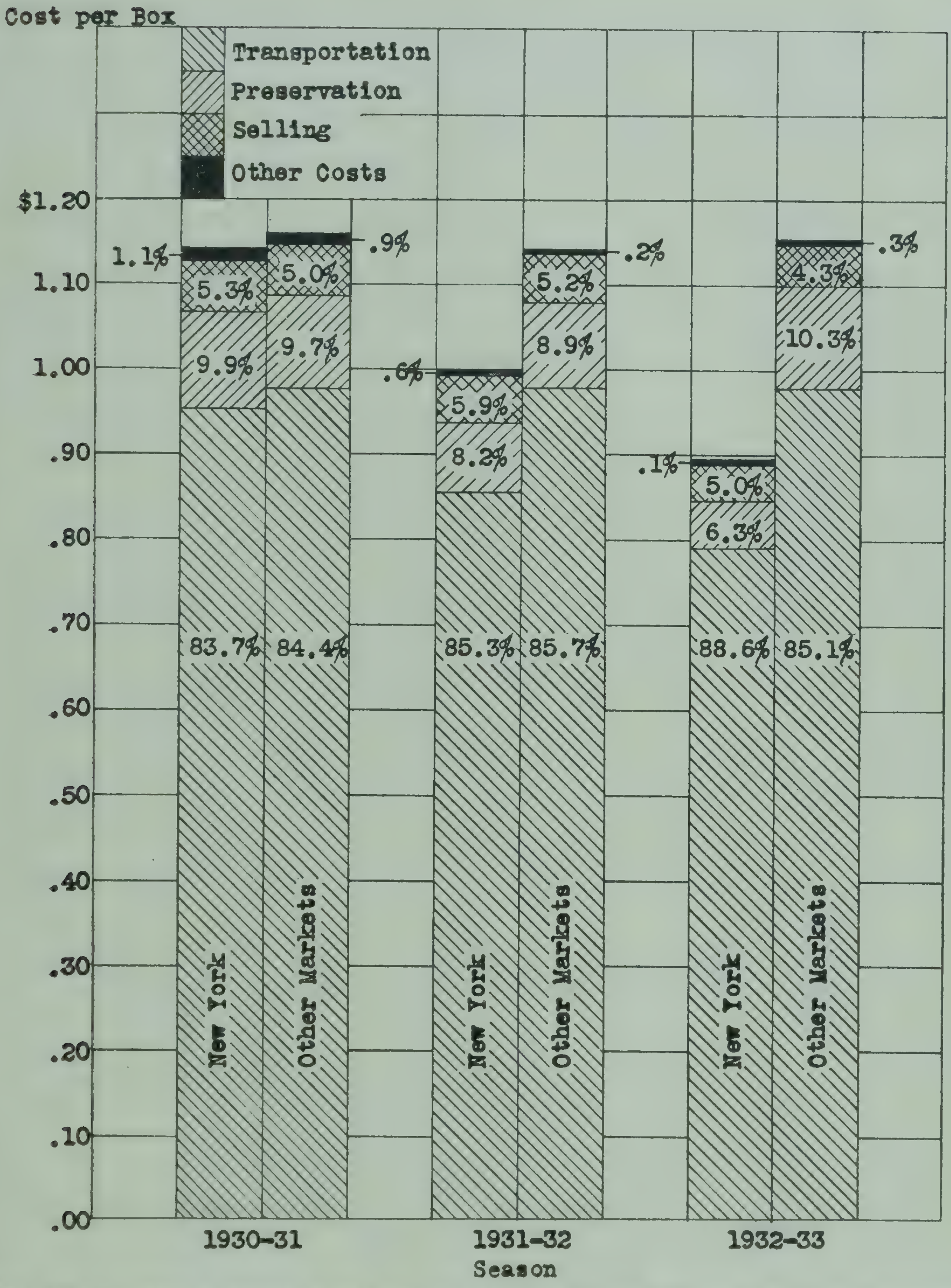

Fig. 29.—Season average cost of marketing Florida citrus fruit at auction in five markets.

apply to rail routes and were somewhat smaller and less frequent to New York than to "Other Markets".

In 1930-31 when practically all of the citrus fruit in this study moved by rail the average total cost per box to New York was very little lower than the average total cost to "Other Markets". In 1931-32 the total cost per box to New York was reduced mainly by the use of cheaper transportation, and in 1932-33 it was further reduced, while the average total cost to the "Other Markets" remained almost constant. This condition made it much cheaper to send fruit to the New York auction than to the auctions of the "Other Markets" (Fig. 29).

NET RETURNS TO THE SHIPPER FROM AUCTION SALES

The average monthly net returns to the shipper for oranges by variety and grade are shown in Tables 18, 19, and 20. These averages represent the net amount which the shipping agency received for fruit sent to auction and were arrived at as follows: From the average auction price each month in New York was deducted the average total cost of marketing at auction in New York for that month. A similar procedure was used to obtain the net return on fruit sent to "Other Markets". Monthly net returns from New York and from "Other Markets" were weighted each month by the volume of fruit to obtain the average net return for all markets. If only one of the markets was represented in a given month, the net return for that market (or group) was carried over to all markets at the same figure. Season average net returns were obtained for each of the market groups by weighting the monthly net returns by the volume of fruit in each. The net returns on grapefruit, Temples and tangerines were arrived at in the same manner as for oranges.

From the standpoint of net returns to the shipper, New York was usually a better market for Florida oranges during the three seasons than were the "Other Markets". This was especially true for grade 1 fruit. Even in 1932-33, when auction prices were frequently lower in New York than in "Other Markets", the net returns for grade 1 fruit sold there were usually as high as or higher than for the same grade in the "Other Markets", because of lower costs of transportation to New York. Most cases where net return from oranges on the New York auction was less than from other auctions are confined to grade 2.

Grapefruit also returned more to the shipper when sent to the New York auction, except in 1932-33 when other auctions seemed to provide a better market (Tables 21, 22, and 23). Temples and tangerines showed a higher net return each of the seasons in New York than in "Other Markets" (Tables 24 and 25).

TABLE 18.—FLORIDA ORANGES—MONTHLY NET RETURNS PER BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS, BY VARIETY AND GRADE.

Month Sold	Parson Brown																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
1930-31																		
September-October							7,156	$3.74			7,156	$3.74	542	$3.59	360	$3.16	902	$3.42
November							10,260	2.43	1,732	$2.50	11,992	2.44	1,334	1.85	4,772	1.54	6,106	1.61
December							136	1.73			136	1.73			898	1.12	898	1.12
Total or average							17,552	$2.96	1,732	$2.50	19,284	$2.92	1,876	$2.35	6,030	$1.57	7,906	$1.76
1931-32																		
September-October									40	$1.09	40	$1.09			97	$0.43	97	$0.43
November							2,169	$2.13	188	1.82	2,357	2.11	898	$1.49	431	1.29	1,329	1.43
December	289	$2.43			289	$2.43	843	1.95			843	1.95	682	2.13			682	2.13
January	6	2.78			6	2.78	10	2.15			10	2.15						
Total or average	295	$2.44			295	$2.44	3,022	$2.08	228	$1.69	3,250	$2.05	1,580	$1.77	528	$1.13	2,108	$1.61
1932-33																		
September-October							81	$1.71			81	$1.71	66	$1.24			66	$1.24
November	23	$2.32			23	$2.32	2,942	2.36			2,942	2.36	1,092	1.74	542	$2.33	1,634	1.94
December							331	2.40			331	2.40			346	2.09	346	2.09
January																		
February													105	.99			105	.99
Total or average	23	$2.32			23	$2.32	3,354	$2.35			3,354	$2.35	1,263	$1.65	888	$2.24	2,151	$1.89

TABLE 18.—FLORIDA ORANGES—MONTHLY NET RETURNS PER BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS, BY VARIETY AND GRADE *(Continued)*.

Month Sold	Pineapple																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
1930-31																		
September-October	390	$4.51			390	$4.51	257	$2.95			257	$2.95	157	$3.33			157	$3.33
November	5,100	3.71	22	$3.48	5,122	3.71	6,817	2.68	3,431	$2.31	10,248	2.56	857	2.05	4,183	$1.68	5,040	1.74
December	5,860	2.98	41	2.71	5,901	2.98	14,570	2.36	5,798	2.18	20,368	2.31	2,482	2.05	6,066	1.54	8,548	1.69
January	6,386	2.76	13	2.90	6,399	2.76	22,984	2.21	5,920	2.00	28,904	2.17	4,352	1.84	5,739	1.58	10,091	1.69
February	4,824	2.79	561	2.30	5,385	2.74	18,008	2.41	7,010	2.11	25,018	2.33	8,197	1.96	6,618	1.87	14,815	1.92
March	4,799	3.38	174	2.96	4,973	3.37	13,447	2.96	4,573	2.80	18,020	2.92	4,025	2.57	1,548	2.43	5,573	2.53
April	514	3.21	55	2.64	569	3.15	1,053	2.81	249	2.19	1,302	2.69			26	2.47	26	2.47
May							10	2.23			10	2.23	12	2.25			12	2.25
Total or average	27,873	$3.12	866	$2.51	28,739	$3.11	77,146	$2.47	26,981	$2.24	104,127	$2.41	20,082	$2.08	24,180	$1.72	44,262	$1.89
1931-32																		
November	600	$2.47	1	$1.89	601	$2.47	2,028	$2.66	1,688	$2.36	3,716	$2.52	946	$2.08	819	$1.68	1,765	$1.89
December	2,623	2.99	233	2.19	2,856	2.92	13,428	2.53	3,519	2.07	16,947	2.43	4,593	1.89	2,166	1.72	6,759	1.84
January	4,894	2.66	103	2.95	4,997	2.67	21,690	2.38	5,568	2.07	27,258	2.32	7,046	2.07	5,246	1.67	12.292	1.90
February	1,680	3.06	166	2.66	1,846	3.02	21,405	2.66	5,192	2.33	26,597	2.60	7,752	2.35	6,408	2.10	14,160	2.24
March	388	4.01			388	4.01	6,196	3.07			6,196	3.07	2,647	2.40	1,332	2.54	3,979	2.45
April	456	3.45			456	3.45	75	2.98			75	2.98	60	2.39	3	2.20	63	2.38
May							60	3.46			60	3.46	319	2.92			319	2.92
Total or average	10,641	$2.88	503	$2.50	11,144	$2.86	64.882	$2.58	15,967	$2.19	80,849	$2.50	23.363	$2.18	15,974	$1.92	39,337	$2.07
1932-33																		
November	111	$3.35			111	$3.35	2,497	$2.74	23	$1.91	2,520	$2.73	567	$1.92	1,356	$2.04	1,923	$2.00
December	4,077	2.69	95	$2.01	4,172	2.67	21,586	2.12	7,150	1.77	28,736	2.03	5,166	1.65	7,037	1.61	12.203	1.63
January	3,321	2.79	180	2.26	3,501	2.76	22,452	2.20	3,619	1.98	26,071	2.17	4,480	1.45	7,454	1.72	11.934	1.62
February	2,208	2.56	233	2.01	2.441	2.51	18,612	1.98	2,853	1.69	21,465	1.94	7,921	1.32	6,876	1.52	14,797	1.41
March	2,550	2.91	279	1.90	2,829	2.81	14,584	2.02	2,762	1.60	17,346	1.95	10,598	1.41	5,726	1.35	16,324	1.39
April	524	2.65			524	2.65	4,568	1.73	919	1.60	5,487	1.71	1,311	1.15	1,508	.96	2,819	1.05
May	19	1.51			19	1.51	1,348	1.28			1,348	1.28	325	1.13			325	1.13
Total or average	12,810	$2.74	787	$2.03	13,597	$2.70	85,647	$2.08	17,326	$1.76	102,973	$2.02	30,368	$1.43	29,957	$1.55	60,325	$1.49

TABLE 18.—FLORIDA ORANGES—MONTHLY NET RETURNS PER BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS, BY VARIETY AND GRADE *(Continued)*.

Month Sold	Valencia																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
1930-31																		
February							839	$2.78			839	$2.78	931	$1.85			931	$1.85
March	2,666	$2.98	13	$2.98	2,679	$2.98	24,735	2.66	8,539	$2.62	33,274	2.65	2,515	2.25	4,818	$2.28	7,333	2.27
April	1,708	3.16	29	2.86	1,737	3.15	31,905	2.86	10,224	2.66	42,129	2.81	9,161	2.57	11,834	2.55	20,995	2.56
May	7,209	3.18	725	2.83	7,934	3.15	51,850	2.78	24,552	2.64	76,402	2.74	16,076	2.52	27,003	2.42	43,079	2.46
June	508	3.77			508	3.77	30,223	3.07	12,735	2.72	42,958	2.97	14,964	2.49	14,205	2.27	29,169	2.38
July-August							1,717	2.97			1,717	2.97	1,627	2.49	180	1.90	1,807	2.43
Total or average	12,091	$3.16	767	$2.83	12,858	$3.14	141,269	$2.84	56,050	$2.66	197,319	$2.79	45,274	$2.49	58,040	$2.40	103,314	$2.44
1931-32																		
February	283	$3.78			283	$3.78	329	$2.46			329	$2.46						
March	4,549	3.50	71	$3.40	4,620	3.50	33,100	3.11	6,694	$2.55	39,794	3.02	6,011	$2.66	8,357	$2.68	14,368	$2.67
April	4,966	3.72	32	4.18	4,998	3.72	33,278	3.02	8,396	2.78	41,674	2.97	7,748	2.64	15,240	2.69	22,988	2.67
May	111	3.66			111	3.66	41,214	2.84	10,518	2.49	51,732	2.77	15,852	2.39	15,128	2.30	30,980	2.35
June							21,914	2.69	963	2.54	22,877	2.68	12,123	2.34	872	2.46	12,995	2.35
Total or average	9,909	$3.62	103	$3.64	10,012	$3.62	129,835	$2.93	26,571	$2.60	156,406	$2.87	41,734	$2.46	39,597	$2.53	81,331	$2.50
1932-33																		
March	235	$2.65	30	$2.13	265	$2.59	5,942	$1.86	338	$1.68	6,280	$1.85	4,072	$1.39	1,446	$1.19	5,518	$1.34
April	1,503	2.76			1,503	2.76	22,364	1.88	3,715	1.50	26,079	1.83	15,053	1.34	22,352	1.24	37,405	1.28
May	3,389	2.40	575	1.66	3,964	2.29	31,945	1.61	6,593	1.36	38,538	1.57	31,022	1.19	42,110	1.06	73,132	1.12
June	581	3.03	227	2.14	808	2.78	10,436	1.97	1,627	1.89	12,063	1.96	29,978	1.41	10,715	1.35	40,693	1.39
July-August							1,168	2.11	37	2.12	1,205	2.11	6,250	1.97	724	1.76	6,974	1.95
Total or average	5,708	$2.57	832	$1.81	6,540	$2.47	71,855	$1.78	12,310	$1.49	84,165	$1.73	86,375	$1.36	77,347	$1.16	163,722	$1.27

TABLE 18.—FLORIDA ORANGES—MONTHLY NET RETURNS PER BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS, BY VARIETY AND GRADE *(Concluded)*.

Month Sold	Other Varieties																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
1930-31																		
September-October							4,508	$3.72	2,539	$3.18	7,047	$3.53	1,096	$2.40	1,981	$2.15	3,077	$2.24
November	1,260	$2.74	38	$3.72	1,298	$2.77	22,024	2.56	10,606	1.69	32,630	2.28	4,403	1.62	6,781	1.27	11,184	1.41
December	1,159	2.43	352	2.50	1,511	2.45	20,384	1.92	6,309	1.71	26,693	1.87	4,798	1.59	7,974	1.23	12,772	1.37
January	3,084	2.04	87	2.89	3,171	2.06	20,606	1.92	5,726	1.63	26,332	1.86	7,282	1.56	8,063	1.36	15,345	1.45
February	5,605	2.32	255	1.99	5,860	2.31	19,341	2.09	7,752	1.93	27,093	2.04	3,726	1.95	7,271	1.76	10,997	1.82
March	3,619	2.90			3,619	2.90	16,039	2.71	1,268	2.67	17,307	2.71	3,702	2.34	1,881	2.55	5,583	2.41
April	981	2.76	3	2.89	984	2.76	7,903	2.61	1,548	3.00	9,451	2.67	785	2.43	860	2.42	1,645	2.42
May	2,121	3.03			2,121	3.03	2,909	2.71	1,110	2.96	4,019	2.78	940	2.00	529	2.72	1,469	2.26
June							2,082	2.96			2,082	2.96	487	2.08	360	1.69	847	1.91
July-August							360	3.02			360	3.02						
Total or average	17,829	$2.53	735	$2.42	18,564	$2.53	116,156	$2.34	36,858	$1.96	153,014	$2.25	27,219	$1.82	35,700	$1.55	62,919	$1.67
1931-32																		
September-October									744	$1.69	744	$1.69			30	$0.12	30	$0.12
November	187	$3.51			187	$3.51	9,300	$2.42	3,700	1.91	13,000	2.27	1,862	$1.71	2,075	1.39	3,937	1.54
December	1,675	2.65	145	$2.13	1,820	2.61	15,956	2.20	4,862	1.86	20,818	2.12	7,566	1.78	3,273	1.53	10,839	1.70
January	1,055	2.37	114	2.65	1,169	2.40	17,163	2.03	2,215	1.89	19,378	2.01	6,833	1.61	4,656	1.44	11,489	1.54
February	1,042	2.81	79	2.22	1,121	2.77	19,750	2.38	4,027	1.92	23,777	2.30	8,973	2.13	4,869	1.88	13,842	2.04
March	819	3.55	16	3.23	835	3.54	7,611	2.64	2,916	2.45	10,527	2.59	5,077	2.29	2,212	2.17	7,289	2.25
April	368	3.41			368	3.41	2,637	2.94	1,120	2.65	3,757	2.85	1,076	2.47	1,117	2.66	2,193	2.57
May							1,495	2.76	816	2.96	2,311	2.83	299	2.36	822	2.27	1,121	2.29
June							672	2.49			672	2.49	473	2.53			473	2.53
Total or average	5,146	$2.85	354	$2.37	5,500	$2.82	74,584	$2.32	20,400	$2.05	94,984	$2.26	32,159	$1.96	19,054	$1.75	51,213	$1.88
1932-33																		
September-October									63	$2.49	63	$2.49						
November	281	$2.56	37	$2.52	318	$2.56	7,767	$2.45	2,991	2.01	10,758	2.33	2,261	$1.78	2,067	$1.60	4,328	$1.69
December	256	1.73	97	2.26	353	1.88	18,659	1.80	2,353	1.60	21,012	1.78	5,605	1.36	2,470	1.58	8,075	1.43
January	317	2.27			317	2.27	14,211	1.79	3,710	1.67	17,921	1.77	8,097	1.42	3,953	1.47	12,050	1.44
February	285	2.53	81	2.33	366	2.49	13,410	1.55	3,630	1.69	17,040	1.58	12,471	1.08	6,494	1.36	18,965	1.18
March	206	2.30	203	2.03	409	2.17	17,699	1.52	2,182	1.59	19,881	1.53	21,765	1.21	4,844	1.33	26,609	1.23
April	113	1.88	29	2.03	142	1.91	12,556	1.23	2,521	1.22	15,077	1.23	13,013	.97	2,235	1.05	15,248	.98
May	340	2.63			340	2.63	2,286	1.52	5	.84	2,291	1.52	2,585	1.00	1,171	.86	3,756	.96
June	94	8.15			94	3.15	972	2.16			972	2.16	2,605	1.57			2,605	1.57
July-August													118	1.85			118	1.85
Total or average	1,892	$2.37	447	$2.17	2,339	$2.33	87,560	$1.68	17,455	$1.65	105,015	$1.67	68,520	$1.20	23,234	$1.36	91,754	$1.24

TABLE 19.—FLORIDA ORANGES—MONTHLY NET RETURNS PER BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS, BY VARIETY, ALL GRADES COMBINED[1].

Month Sold	Parson Brown						Pineapple						Valencia					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
1930-31																		
September-October	7,698	$3.73	360	$3.16	8,058	$3.70	875	$3.66			875	$3.66						
November	11,594	2.37	6,504	1.79	18,098	2.16	12,784	3.04	7,636	$1.97	20,420	2.64						
December	136	1.73	898	1.12	1,034	1.20	22,912	2.49	11,905	1.85	34,817	2.27						
January							33,722	2.27	11,672	1.79	45,394	2.15						
February							31,029	2.35	14,189	2.00	45,218	2.24	1,770	$2.29			1,770	$2.29
March							22,271	2.98	6,295	2.71	28,566	2.92	29,934	2.65	13,370	$2.50	43,304	2.60
April							1,567	2.94	330	2.29	1,897	2.83	42,774	2.81	22,087	2.60	64,861	2.74
May							28	2.15			28	2.15	75,189	2.76	53,701	2.52	128,890	2.66
June													45,761	2.89	27,276	2.47	73,037	2.73
July-August													3,759	2.69	180	1.90	3,939	2.65
Total or average	19,428	$2.90	7,762	$1.78	27,190	$2.58	125,188	$2.55	52,027	$2.00	177,215	$2.39	199,187	$2.78	116,614	$2.52	315,801	$2.68
1931-32																		
September-October			137	$0.62	137	$0.62												
November	3,067	$1.94	619	1.45	3,686	1.86	3,574	$2.48	2,508	$2.14	6,082	$2.34						
December	1,814	2.10			1,814	2.10	20,644	2.45	5,918	1.94	26,562	2.34						
January	16	2.39			16	2.39	33,630	2.36	11,048	1.88	44,678	2.24						
February							30,837	2.60	12,260	2.20	43,097	2.49	612	$3.07			612	$3.07
March							9,231	2.92	1,332	2.54	10,563	2.87	43,732	3.08	15,470	$2.62	59,202	2.96
April							591	3.28	3	2.20	594	3.27	46,338	3.02	24,051	2.71	70,389	2.91
May							379	3.01			379	3.01	57,347	2.72	26,569	2.37	83,916	2.61
June													34,137	2.56	2,118	2.43	36,255	2.55
Total or average	4,897	$2.00	756	$1.30	5,653	$1.91	98,886	$2.52	33,069	$2.06	131,955	$2.40	182,166	$2.85	68,208	$2.55	250,374	$2.77
1932-33																		
September-October	147	$1.50			147	$1.50												
November	4,466	2.12	542	$2.33	5,008	2.14	3,175	$2.61	1,379	$2.04	4,554	$2.44						
December	331	2.40	346	2.09	677	2.24	30,829	2.12	14,333	1.70	45,162	1.99						
January							30,373	2.15	11,253	1.81	41,626	2.06						
February	105	.99			105	.99	28,791	1.84	9,997	1.58	38,788	1.77						
March							28,259	1.86	8,811	1.44	37,070	1.76	10,792	$1.67	1,814	$1.30	12,606	$1.62
April							6,403	1.69	2,427	1.20	8,830	1.56	39,863	1.69	26,579	1.26	66,442	1.52
May							1,692	1.26			1,692	1.26	67,983	1.44	49,278	1.11	117,261	1.30
June													42,804	1.55	12,706	1.44	55,510	1.52
July-August													8,159	1.96	761	1.77	8,920	1.94
Total or average	5,049	$2.10	888	$2.24	5,937	$2.12	129,522	$1.99	48,200	$1.64	177,722	$1.89	169,601	$1.57	91,138	$1.21	260,739	$1.44

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[1] Includes a small amount of Grade 3 fruit.

TABLE 19.—FLORIDA ORANGES—MONTHLY NET RETURNS PER BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS, BY VARIETY, ALL GRADES COMBINED[1] *(Concluded).*

Month Sold	Other Varieties						All Varieties					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
						1930-31						
September-October	5,632	$3.45	4,584	$2.70	10,216	$3.11	14,205	$3.61	4,944	$2.74	19,149	$3.39
November	27,687	2.42	17,895	1.52	45,582	2.07	52,065	2.56	32,035	1.68	84,100	2.22
December	26,437	1.88	14,675	1.47	41,112	1.73	49,485	2.16	27,478	1.62	76,963	1.97
January	30,972	1.85	13,876	1.48	44,848	1.74	64,694	2.07	25,548	1.62	90,242	1.94
February	28,672	2.11	15,278	1.85	43,950	2.02	61,471	2.24	29,467	1.92	90,938	2.14
March	23,360	2.68	3,466	2.39	26,826	2.64	75,565	2.76	23,131	2.54	98,696	2.71
April	9,669	2.61	2,411	2.79	12,080	2.65	54,010	2.78	24,828	2.62	78,838	2.73
May	5,970	2.71	1,639	2.88	7,609	2.75	81,187	2.76	55,340	2.53	136,527	2.67
June	2,569	2.79	360	1.69	2,929	2.65	48,330	2.88	27,636	2.46	75,966	2.73
July-August	360	3.02			360	3.02	4,119	2.72	180	1.90	4,299	2.69
Total or average	161,328	$2.27	74,184	$1.76	235,512	$2.11	505,131	$2.57	250,587	$2.16	755,718	$2.43
						1931-32						
September-October			799	$1.56	799	$1.56			936	$1.43	936	$1.43
November	11,349	$2.32	5,775	1.72	17,124	2.12	17,990	$2.29	8,902	1.82	26,892	2.13
December	25,197	2.10	8,280	1.73	33,477	2.01	47,655	2.25	14,198	1.82	61,853	2.15
January	25,051	1.93	7,108	1.59	32,159	1.85	58,697	2.17	18,156	1.77	76,853	2.08
February	29,948	2.32	8,975	1.90	38,923	2.22	61,397	2.47	21,235	2.08	82,632	2.37
March	13,745	2.55	5,144	2.33	18,889	2.49	66,708	2.95	21,946	2.54	88,654	2.85
April	4,081	2.86	2,237	2.66	6,318	2.79	51,010	3.01	26,291	2.71	77,301	2.91
May	1,794	2.69	1,789	2.56	3,583	2.63	59,520	2.72	28,358	2.38	87,878	2.61
June	1,145	2.51	384	1.05	1,529	2.14	35,282	2.56	2,502	2.21	37,784	2.54
Total or average	112,310	$2.24	40,491	$1.90	152,801	$2.15	398,259	$2.59	142,524	$2.24	540,783	$2.50
						1932-33						
September-October			63	$2.49	63	$2.49	147	$1.50	63	$2.49	210	$1.80
November	10,309	$2.31	5,095	1.84	15,404	2.15	17,950	2.31	7,016	1.92	24,966	2.20
December	24,678	1.70	4,927	1.61	29,605	1.69	55,838	1.93	19,606	1.68	75,444	1.87
January	22,654	1.66	7,956	1.55	30,610	1.63	53,027	1.94	19,209	1.70	72,236	1.88
February	26,166	1.34	10,205	1.49	36,371	1.38	55,062	1.60	20,202	1.53	75,264	1.58
March	40,072	1.35	7,556	1.40	47,628	1.36	79,123	1.57	18,181	1.41	97,304	1.54
April	25,756	1.10	4,833	1.14	30,589	1.11	72,022	1.48	33,839	1.24	105,861	1.40
May	5,211	1.34	1,176	.86	6,387	1.25	74,886	1.43	50,454	1.10	125,340	1.30
June	3,728	1.76			3,728	1.76	46,532	1.57	12,706	1.44	59,238	1.54
July-August	118	1.85			118	1.85	8,277	1.96	761	1.77	9,038	1.94
Total or average	158,692	$1.48	41,811	$1.49	200,503	$1.48	462,864	$1.66	182,037	$1.39	644,901	$1.58

TABLE 20.—FLORIDA ORANGES—MONTHLY NET RETURNS PER BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS, BY GRADE, ALL VARIETIES COMBINED[1].

Month Sold	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
1930-31																		
September-October	390	$4.51			390	$4.51	11,921	$3.71	2,539	$3.18	14,460	$3.62	1,795	$2.84	2,341	$2.30	4,136	$2.53
November	6,360	3.52	60	$3.63	6,420	3.52	39,101	2.55	15,769	1.91	54,870	2.37	6,594	1.72	15,736	1.46	22,330	1.54
December	7,019	2.89	393	2.52	7,412	2.87	35,090	2.10	12,107	1.94	47,197	2.06	7,280	1.75	14,938	1.35	22,218	1.48
January	9,470	2.52	100	2.81	9,570	2.52	43,590	2.07	11,646	1.82	55,236	2.02	11,634	1.67	13,802	1.45	25,436	1.55
February	10,429	2.54	816	2.21	11,245	2.52	38,188	2.25	14,762	2.01	52,950	2.18	12,854	1.95	13,889	1.81	26,743	1.88
March	11,084	3.13	187	2.96	11,271	3.13	54,221	2.75	14,380	2.68	68,601	2.74	10,242	2.41	8,247	2.37	18,489	2.39
April	3,203	3.04	87	2.72	3,290	3.03	40,861	2.81	12,021	2.70	52,882	2.78	9,946	2.56	12,720	2.54	22,666	2.55
May	9,330	3.15	725	2.83	10,055	3.13	54,769	2.78	25,662	2.66	80,431	2.74	17,028	2.49	27,532	2.43	44,560	2.45
June	508	3.77			508	3.77	32,305	3.07	12,735	2.72	45,040	2.97	15,451	2.48	14,565	2.26	30,016	2.37
July August							2,077	2.98			2,077	2.98	1,627	2.49	180	1.90	1,807	2.43
Total or average	57,793	$2.95	2,368	$2.59	60,161	$2.94	352,123	$2.60	121,621	$2.36	473,744	$2.54	94,451	$2.21	123,950	$1.98	218,401	$2.08
1931-32																		
September-October									784	$1.65	784	$1.65			127	$0.36	127	$0.36
November	787	$2.72	1	$1.89	788	$2.72	13,497	$2.41	5,576	2.04	19,073	2.30	3,706	$1.75	3,325	1.45	7,031	1.61
December	4,587	2.83	378	2.17	4,965	2.78	30,227	2.34	8,381	1.94	38,608	2.25	12,841	1.84	5,439	1.61	18,280	1.77
January	5,955	2.60	217	2.79	6,172	2.61	38,863	2.23	7,783	2.02	46,646	2.19	13,879	1.84	9,902	1.56	23,781	1.72
February	3,005	3.04	245	2.52	3,250	3.00	41,484	2.52	9,219	2.15	50,703	2.45	16,725	2.23	11,277	2.00	28,002	2.14
March	5,756	3.54	87	3.37	5,843	3.54	46,907	3.03	9,610	2.52	56,517	2.94	13,735	2.47	11,901	2.57	25,636	2.52
April	5,790	3.68	32	4.18	5,822	3.68	35,990	3.01	9,516	2.76	45,506	2.96	8,884	2.62	16,360	2.69	25,244	2.67
May	111	3.66			111	3.66	42,769	2.84	11,334	2.52	54,103	2.77	16,470	2.40	15,950	2.30	32,420	2.35
June							22,586	2.68	963	2.54	23,549	2.67	12,596	2.35	872	2.46	13,468	2.36
Total or average	25,991	$3.15	960	$2.57	26,951	$3.13	272,323	$2.67	63,166	$2.31	335,489	$2.60	98,836	$2.22	75,153	$2.20	173,989	$2.21
1932-33																		
September-October							81	$1.71	63	$2.49	144	$2.05	66	$1.24			66	$1.24
November	415	$2.76	37	$2.52	452	$2.74	13,206	2.49	3,014	2.01	16,220	2.40	3,920	1.79	3,965	$1.85	7,885	1.82
December	4,333	2.64	192	2.14	4,525	2.62	40,576	1.98	9,503	1.73	50,079	1.93	10,771	1.50	9,853	1.62	20,624	1.56
January	3,638	2.74	180	2.26	3,818	2.72	36,663	2.04	7,329	1.82	43,992	2.00	12,577	1.43	11,407	1.63	23,984	1.53
February	2,493	2.56	314	2.09	2,807	2.51	32,022	1.80	6,483	1.69	38,505	1.78	20,497	1.17	13,370	1.44	33,867	1.28
March	2,991	2.85	512	1.97	3,503	2.72	38,225	1.76	5,282	1.60	43,507	1.74	36,435	1.29	12,016	1.32	48,451	1.30
April	2,140	2.68	29	2.03	2,169	2.67	39,488	1.65	7,155	1.41	46,643	1.61	29,377	1.17	26,095	1.21	55,472	1.19
May	3,748	2.42	575	1.66	4,323	2.32	35,579	1.60	6,598	1.36	42,177	1.56	33,932	1.17	43,281	1.05	77,213	1.10
June	675	3.04	227	2.14	902	2.81	11,408	1.99	1,627	1.89	13,035	1.98	32,583	1.43	10,715	1.35	43,298	1.41
July-August							1,168	2.11	37	2.12	1,205	2.11	6,368	1.97	724	1.76	7,092	1.95
Total or average	20,433	$2.66	2,066	$1.97	22,499	$2.60	248,416	$1.85	47,091	$1.65	295,507	$1.82	186,526	$1.32	131,426	$1.29	317,952	$1.31

[1] Includes a small amount of Grade 3 fruit.

TABLE 21.—FLORIDA GRAPEFRUIT—MONTHLY NET RETURNS PER BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS, BY VARIETY AND GRADE.

Month Sold	Marsh Seedless																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
1930-31																		
September-October									81	-$.46	81	-$.46			206	-$.69	206	-$.69
November									26	2.57	26	2.57			39	2.26	39	2.26
December							517	$3.60	22	1.09	539	3.50	83	$3.34			83	3.34
January							1,034	3.31	1,838	2.34	2,872	2.69	182	2.18	934	1.83	1,116	1.89
Februray	15	$3.31			15	$3.31	4,728	2.06	1,211	1.94	5,939	2.04	356	1.78	1,894	1.55	2,250	1.59
March	612	1.93			612	1.93	6,653	2.52	2,099	1.80	8,752	2.35	799	1.50	1,774	1.90	2,573	1.78
April	1,445	2.61	152	$2.19	1,597	2.57	14,735	2.63	7,962	1.97	22,697	2.40	3,233	1.73	9,170	1.51	12,403	1.57
May	3,323	2.37	463	2.19	3,786	2.35	24,712	2.06	9,802	1.53	34,514	1.91	6,179	1.05	15,517	1.04	21,696	1.04
June	493	2.16	27	2.82	520	2.19	13,120	1.30	8,336	1.15	21,456	1.24	8,810	.56	15,253	.61	24,063	.59
July-August							1,786	.08	224	.12	2,010	.08	1,319	.22	771	1.06	2,090	.53
Total or average	5,888	$2.37	642	$2.22	6,530	$2.35	67,285	$2.06	31,601	$1.61	98,886	$1.92	20,961	$0.95	45,558	$1.06	66,519	$1.02
1931-32																		
September-October							23	$2.91			23	$2.91	21	$2.63			21	$2.63
November							691	2.08	154	$2.27	845	2.11	684	1.73	270	$1.50	954	1.66
December							1,758	2.14	358	1.49	2,116	2.03	582	1.46	469	1.27	1,051	1.38
January	610	$2.44			610	$2.44	1,297	1.98	595	1.40	1,892	1.80	250	1.76	725	.92	975	1.14
February	2,240	1.89	53	$1.36	2,293	1.88	11,728	1.57	3,108	1.22	14,836	1.50	2,422	.95	3,044	.95	5,466	.95
March	1,829	2.34	45	1.59	1,874	2.32	14,902	2.02	3,179	1.40	18,081	1.91	4,309	1.61	4,574	1.26	8,883	1.43
April	1,363	2.52	85	2.59	1,448	2.52	14,486	2.47	8,564	1.92	23,050	2.27	7,201	1.83	5,676	1.68	12,877	1.76
May							14,671	2.86	7,544	2.72	22,215	2.81	9,030	2.37	2,008	2.38	11,038	2.37
June							4,540	3.53	108	2.67	4,648	3.51	1,810	2.80	463	2.21	2,273	2.68
Total or average	6,042	$2.22	183	$1.99	6,225	$2.22	64,096	$2.34	23,610	$2.00	87,706	$2.25	26,309	$1.95	17,229	$1.49	43,538	$1.77
1932-33																		
September-October									16	$2.23	16	$2.23			22	$1.96	22	$1.96
November	223	$3.95			223	$3.95	1,370	$3.21	102	3.11	1,472	3.20	1,132	$2.60	121	1.84	1,253	2.53
December	30	2.78			30	2.78	1,149	2.34	2,369	2.91	3,518	2.72	1,705	1.47	1,354	1.99	3,059	1.70
January	255	3.57			255	3.57	1,755	2.42	388	2.72	2,143	2.47	1,193	1.17	168	1.87	1,361	1.26
February	490	3.34			490	3.34	3,373	2.57	1,209	2.34	4,582	2.51	1,766	1.42	1,447	1.72	3,213	1.56
March	841	2.95	82	$2.55	873	2.94	7,755	2.16	3,874	2.20	11,629	2.17	4,821	1.44	7,164	1.52	11,985	1.49
April	1,845	2.52			1,845	2.52	7,776	1.93	5,293	2.19	13,069	2.04	6,588	1.11	8,023	1.40	14,611	1.27
May	415	2.00	67	2.30	482	2.04	5,186	1.25	4,886	1.62	10,072	1.43	11,889	.83	9,269	.92	21,158	.87
June			63	2.21	63	2.21	2,364	1.33	2,175	1.29	4,539	1.31	3,426	.93	4,119	.97	7,545	.95
July-August							3,708	1.78	664	.86	4,372	1.64	10,517	1.24	853	.68	11,370	1.20
Total or average	4,099	$2.80	162	$2.31	4,261	$2.78	34,436	$1.97	20,976	$2.03	55,412	$1.99	43,037	$1.15	32,540	$1.26	75,577	$1.20

TABLE 21.—FLORIDA GRAPEFRUIT—MONTHLY NET RETURNS PER BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS, BY VARIETY AND GRADE *(Concluded)*.

Month Sold	Other Varieties																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
									1930-31									
September-October							21,945	$2.91	12,224	$2.36	34,169	$2.71	5,702	$2.36	13,751	$1.77	19,453	$1.94
November	4,873	$2.37	1,144	$2.18	6,017	$2.33	27,073	2.37	16,417	1.82	43,490	2.16	6,674	1.83	10,874	1.49	17,548	1.62
December	1,944	2.43	529	2.26	2,473	2.39	24,234	2.11	18,589	1.71	42,823	1.94	5,069	1.59	15,699	1.25	20,768	1.33
January	3,294	2.12	73	2.61	3,367	2.13	28,957	1.98	20,388	1.70	49,345	1.86	5,681	1.30	26,525	1.31	32,206	1.31
February	1,022	2.05	27	2.38	1,049	2.06	23,084	1.83	11,667	1.61	34,751	1.76	3,258	1.25	16,855	1.15	20,113	1.17
March	3,673	1.84	257	1.78	3,930	1.84	23,376	1.72	12,219	1.56	35,595	1.67	1,380	1.16	13,250	1.23	14,630	1.22
April	3,466	2.41	188	1.95	3,654	2.39	19,116	1.81	5,176	1.56	24,292	1.76	7,865	1.35	11,776	1.17	19,641	1.24
May	304	2.24	92	2.36	396	2.27	17,744	1.23	4,696	1.27	22,440	1.24	5,958	.73	7,356	.76	13,314	.75
June							8,569	.57	1,642	.86	10,211	.62	5,489	.02	3,247	.53	8,736	.21
July-August							211	– .48			211	– .48			360	–1.14	360	–1.14
Total or average	18,576	$2.21	2,310	$2.16	20,886	$2.21	194,309	$1.96	103,018	$1.73	297,327	$1.88	47,076	$1.31	119,693	$1.26	166,769	$1.28
									1931-32									
September-October							11,467	$2.14	9,359	$1.85	20,826	$2.01	2,667	$1.71	8,312	$1.60	10,979	$1.63
November	2,365	$2.27	721	$2.31	3,086	$2.28	24,627	1.96	11,282	1.61	35,909	1.85	11,028	1.34	12,605	1.23	23,633	1.28
December	2,808	1.83	366	1.74	3,174	1.82	29,125	1.52	8,148	1.37	37,273	1.49	15,213	1.01	10,439	1.03	25,652	1.02
January	2,359	1.61	352	1.76	2,711	1.63	25,281	1.40	12,027	1.19	37,308	1.33	11,528	.94	9,441	.85	20,969	.90
February	934	1.50	259	1.55	1,193	1.51	25,121	1.19	5,486	1.04	30,607	1.16	12,328	.71	4,177	.81	16,505	.74
March	868	1.69	18	1.75	886	1.69	17,480	1.62	5,216	1.10	22,696	1.50	9,647	1.14	4,174	.94	13,821	1.08
April	852	2.76	75	2.43	927	2.73	7,124	1.96	2,383	2.03	9,507	1.98	4,574	1.57	2,544	1.73	7,118	1.63
May							1,849	2.46	1,422	2.47	3,271	2.46	2,009	2.19	727	1.65	2,736	2.05
June							585	3.58	54	2.42	639	3.48	1,338	2.40	679	1.14	2,017	1.98
July-August							509	3.78			509	3.78	1,191	2.51			1,191	2.51
Total or average	10,186	$1.92	1,791	$1.97	11,977	$1.93	143,168	$1.63	55,377	$1.46	198,545	$1.58	71,523	$1.16	53,098	$1.15	124,621	$1.16
									1932-33									
September-October			22	$3.28	22	$3 28	3,954	$2.54	5,596	$2.81	9,550	$2.70	2,148	$2.29	4,824	$2.10	6,972	$2.16
November	391	$2.66	680	2.27	1,071	2.41	15,984	2.20	9,777	2.37	25,761	2.26	11,216	1.82	9,599	1.69	20,815	1.76
December	788	2.54	392	1.39	1,180	2.16	18,093	1.45	9,907	1.97	28,000	1.63	19,317	.93	14,283	1.24	33,600	1.06
January	643	2.72	14	2.06	657	2.71	10,748	1.55	5,399	1.71	16,147	1.60	8,870	.93	10,160	1.16	19,030	1.05
February	464	2.52	13	1.72	477	2.50	10,886	1.51	5,582	1.72	16,468	1.58	9,915	.86	11,943	1.11	21,858	1.00
March	617	2.22	89	2.04	706	2.20	11,106	1.27	2,754	1.49	13,860	1.31	17,660	.60	13,709	.81	31,369	.70
April	162	2.26			162	2.26	6,546	1.28	1,005	.71	7,551	1.20	11,514	.71	6,589	.65	18,103	.69
May							1,861	1.12	1,602	.82	3,463	.98	4,908	.55	2,104	.30	7,012	.47
June			185	1.51	185	1.51	1,367	1.43	328	1.65	1,695	1.47	3,089	.73	1,558	.46	4,647	.64
July-August							1,266	1.30	256	1.28	1,522	1.30	6,753	.95	990	.77	7,743	.93
Total or average	3,065	$2.51	1,395	$1.92	4,460	$2.32	81,811	$1.62	42,206	$2.00	124,017	$1.75	95,390	$0.95	75,759	$1.14	171,149	$1.03

TABLE 22.—FLORIDA GRAPEFRUIT—MONTHLY NET RETURNS PER BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS BY VARIETY, ALL GRADES COMBINED[1].

Month Sold	Marsh Seedless						Other Varieties						All Grapefruit					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
									1930-31									
September-October			287	-$.62	287	-$.62	27,763	$2.80	26,446	$2.04	54,209	$2.43	27,763	$2.80	26,733	$2.01	54,496	$2.41
November			65	2.38	65	2.38	38,700	2.27	28,501	1.71	67,201	2.03	38,700	2.27	28,566	1.71	67,266	2.03
December	600	$3.57	22	1.09	622	3.48	31,247	2.05	34,817	1.51	66,064	1.77	31,847	2.08	34,839	1.51	66,686	1.78
January	1,216	3.14	3,132	2.06	4,348	2.36	37,932	1.89	46,986	1.48	84,918	1.66	39,148	1.93	50,118	1.52	89,266	1.70
February	5,099	2.05	3,477	1.56	8,576	1.85	27,364	1.77	28,549	1.34	55,913	1.55	32,463	1.82	32,026	1.37	64,489	1.60
March	8,064	2.37	4,050	1.83	12,114	2.19	28,429	1.71	26,579	1.38	55,008	1.55	36,493	1.86	30,629	1.44	67,122	1.67
April	19,413	2.48	17,421	1.72	36,834	2.12	30,447	1.76	17,543	1.30	47,990	1.59	49,860	2.04	34,964	1.51	84,824	1.82
May	34,214	1.91	25,822	1.24	60,036	1.62	24,006	1.12	12,572	.95	36,578	1.06	58,220	1.58	38,394	1.15	96,614	1.41
June	22,426	1.02	23,693	.80	46,119	.91	14,059	.36	4,889	.64	18,948	.43	36,485	.77	28,582	.77	65,067	.77
July-August	3,105	.14	995	.85	4,100	.31	211	-.48	360	-1.14	571	-.90	3,316	.10	1,355	.32	4,671	.16
Total or average	94,137	$1.83	78,964	$1.28	173,101	$1.58	260,158	$1.86	227,242	$1.48	487,400	$1.68	354,295	$1.85	306,206	$1.43	660,501	$1.66
									1931-32									
September-October	44	$2.77			44	$2.77	14,201	$2.06	17,927	$1.73	32,128	$1.88	14,245	$2.06	17,927	$1.73	32,172	$1.88
November	1,375	1.90	424	$1.78	1,799	1.87	38,091	1.80	24,665	1.43	62,756	1.65	39,466	1.80	25,089	1.44	64,555	1.66
December	2,340	1.97	827	1.37	3,167	1.81	47,146	1.37	18,954	1.19	66,100	1.32	49,486	1.40	19,781	1.19	69,267	1.34
January	2,157	2.08	1,320	1.13	3,477	1.72	39,168	1.28	22,049	1.04	61,217	1.19	41,325	1.32	23,369	1.05	64,694	1.22
February	16,390	1.52	6,205	1.09	22,595	1.40	38,383	1.05	9,922	.96	48,305	1.03	54,773	1.19	16,127	1.01	70,900	1.15
March	21,162	1.96	8,133	1.29	29,295	1.77	28,164	1.45	9,767	1.01	37,931	1.34	49,326	1.67	17,900	1.14	67,226	1.53
April	23,213	2.27	15,744	1.81	38,957	2.08	12,581	1.87	5,502	1.76	18,083	1.84	35,794	2.13	21,246	1.80	57,040	2.01
May	24,767	2.65	10,920	2.56	35,687	2.62	3,858	2.32	2,736	2.00	6,594	2.19	28,625	2.60	13,656	2.45	42,281	2.55
June	6,350	3.32	1,054	2.20	7,404	3.16	1,924	2.75	2,452	1.01	4,376	1.78	8,274	3.19	3,506	1.37	11,780	2.65
July-August							1,700	2.89			1,700	2.89	1,700	2.89			1,700	2.89
Total or average	97,798	$2.23	44,627	$1.78	142,425	$2.09	225,216	$1.49	113,974	$1.31	339,190	$1.43	323,014	$1.71	158,601	$1.44	481,615	$1.62
									1932-33									
September-October			38	$2.07	38	$2.07	6,152	$2.45	10,822	$2.47	16,974	$2.46	6,152	$2.45	10,860	$2.47	17,012	$2.46
November	2,725	$3.02	223	2.42	2,948	2.97	27,644	2.05	20,715	2.01	48,359	2.03	30,369	2.14	20,938	2.01	51,307	2.09
December	2,924	1.84	3,723	2.57	6,647	2.25	38,387	1.21	24,686	1.54	63,073	1.34	41,311	1.25	28,409	1.67	69,720	1.42
January	3,203	2.05	556	2.46	3,759	2.11	20,953	1.29	15,636	1.35	36,589	1.32	24,156	1.39	16,192	1.39	40,348	1.39
February	5,638	2.27	2,930	1.95	8,568	2.16	21,809	1.22	18,164	1.30	39,973	1.26	27,447	1.43	21,094	1.39	48,541	1.41
March	14,161	1.91	12,693	1.69	26,854	1.81	29,634	.89	18,192	.89	47,826	.89	43,795	1.22	30,885	1.22	74,680	1.22
April	16,209	1.67	13,864	1.67	30,073	1.67	18,222	.93	7,661	.66	25,883	.85	34,431	1.28	21,525	1.31	55,956	1.29
May	17,490	.98	14,222	1.17	31,712	1.07	6,769	.70	3,706	.53	10,475	.64	24,259	.90	17,928	1.04	42,187	.96
June	5,790	1.09	6,357	1.09	12,147	1.09	4,456	.94	2,071	.74	6,527	.88	10,246	1.03	8,428	1.01	18,674	1.02
July-August	14,225	1.38	1,517	.76	15,742	1.32	8,019	1.01	1,246	.88	9,265	.99	22,244	1.25	2,763	.81	25,007	1.20
Total or average	82,365	$1.58	56,123	$1.54	138,488	$1.57	182,045	$1.28	122,899	$1.44	304,944	$1.34	264,410	$1.37	179,022	$1.47	443,432	$1.41

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[1] Includes a small amount of Grade 3 fruit.

TABLE 23.—FLORIDA GRAPEFRUIT—MONTHLY NET RETURNS PER BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS BY GRADE, ALL VARIETIES COMBINED.

Month Sold	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
									1930-31									
September-October							21,945	$2.91	12,305	$2.34	34,250	$2.71	5,702	$2.36	13,957	$1.74	19,659	$1.92
November	4,873	$2.37	1,144	$2.18	6,017	$2.33	27,073	2.37	16,443	1.82	43,516	2.16	6,674	1.83	10,913	1.50	17,587	1.63
December	1,944	2.43	529	2.26	2,473	2.39	24,751	2.14	18,611	1.71	43,362	1.96	5,152	1.62	15,699	1.25	20,851	1.34
January	3,294	2.12	73	2.61	3,367	2.13	29,991	2.02	22,226	1.75	52,217	1.91	5,863	1.33	27,459	1.32	33,322	1.32
February	1,037	2.07	27	2.38	1,064	2.08	27,812	1.87	12,878	1.64	40,690	1.80	3,614	1.31	18,749	1.19	22,363	1.21
March	4,285	1.85	257	1.78	4,542	1.85	30,029	1.90	14,318	1.59	44,347	1.80	2,179	1.29	15,024	1.31	17,203	1.31
April	4,911	2.47	340	2.06	5,251	2.44	33,851	2.17	13,138	1.81	46,989	2.07	11,098	1.46	20,946	1.32	32,044	1.37
May	3,627	2.36	555	2.22	4,182	2.34	42,456	1.71	14,498	1.45	56,954	1.64	12,137	.89	22,873	.95	35,010	.93
June	493	2.16	27	2.82	520	2.19	21,689	1.01	9,978	1.10	31,667	1.04	14,299	.35	18,500	.60	32,799	.49
July-August							1,997	.02	224	.12	2,221	.03	1,319	.22	1,131	.36	2,450	.28
Total or average	24,464	$2.25	2,952	$2.17	27,416	$2.24	261,594	$1.98	134,619	$1.70	396,213	$1.89	68,037	$1.20	165,251	$1.21	233,288	$1.20
									1931-32									
September-October							11,490	$2.15	9,359	$1.85	20,849	$2.02	2,688	$1.72	8,312	$1.60	11,000	$1.63
November	2,365	$2.27	721	$2.31	3,086	$2.28	25,318	1.96	11,436	1.62	36,754	1.85	11,712	1.36	12,875	1.23	24,587	1.29
December	2,808	1.83	366	1.74	3,174	1.82	30,883	1.55	8,506	1.37	39,389	1.51	15,795	1.02	10,908	1.04	26,703	1.03
January	2,969	1.78	352	1.76	3,321	1.78	26,578	1.43	12,622	1.20	39,200	1.36	11,778	.96	10,166	.86	21,944	.91
February	3,174	1.78	312	1.52	3,486	1.76	36,849	1.31	8,594	1.11	45,443	1.27	14,750	.75	7,221	.87	21,971	.79
March	2,697	2.13	63	1.63	2,760	2.12	32,382	1.80	8,395	1.21	40,777	1.68	13,956	1.28	8,748	1.11	22,704	1.21
April	2,215	2.61	160	2.51	2,375	2.60	21,610	2.30	10,947	1.94	32,557	2.18	11,775	1.73	8,220	1.70	19,995	1.72
May							16,520	2.81	8,966	2.68	25,486	2.76	11,039	2.34	2,735	2.18	13,774	2.31
June							5,125	3.54	162	2.59	5,287	3.51	3,148	2.63	1,142	1.57	4,290	2.35
July-August							509	3.78			509	3.78	1,191	2.51			1,191	2.51
Total or average	16,228	$2.03	1,974	$1.98	18,202	$2.03	207,264	$1.85	78,987	$1.62	286,251	$1.79	97,832	$1.37	70,327	$1.24	168,159	$1.32
									1932-33									
September-October			22	$3.28	22	$3.28	3,954	$2.54	5,612	$2.80	9,566	$2.69	2,148	$2.29	4,846	$2.10	6,994	$2.16
November	614	$3.13	680	2.27	1,294	2.68	17,354	2.28	9,879	2.37	27,233	2.31	12,348	1.89	9,720	1.69	22,068	1.80
December	818	2.55	392	1.39	1,210	2.17	19,242	1.51	12,276	2.15	31,518	1.76	21,022	.98	15,637	1.31	36,659	1.12
January	898	2.96	14	2.06	912	2.95	12,503	1.67	5,787	1.78	18,290	1.70	10,063	.96	10,328	1.17	20,391	1.07
February	954	2.94	13	1.72	967	2.92	14,259	1.76	6,791	1.83	21,050	1.78	11,681	.94	13,390	1.17	25,071	1.06
March	1,458	2.64	121	2.17	1,579	2.60	18,861	1.64	6,628	1.91	25,489	1.71	22,481	.78	20,873	1.06	43,354	.91
April	2,007	2.50			2,007	2.50	14,322	1.63	6,298	1.96	20,620	1.73	18,102	.86	14,612	1.06	32,714	.95
May	415	2.00	67	2.30	482	2.04	7,047	1.21	6,488	1.42	13,535	1.31	16,797	.74	11,373	.81	28,170	.77
June			248	1.69	248	1.69	3,731	1.37	2,503	1.33	6,234	1.35	6,515	.83	5,677	.83	12,192	.83
July-August							4,974	1.66	920	.98	5,894	1.55	17,270	1.13	1,843	.73	19,113	1.09
Total or average	7,164	$2.68	1,557	$1.96	8,721	$2.55	116,247	$1.73	63,182	$2.01	179,429	$1.83	138,427	$1.01	108,299	$1.18	246,726	$1.08

TABLE 24.—FLORIDA MANDARINS—MONTHLY NET RETURNS PER HALF-BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS, BY VARIETY AND GRADE.

Month Sold	Temple																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return
								1930-31										
November							151	$1.12			151	$1.12			145	$0.12	145	$0.12
December															52	.53	52	.53
January	16	$2.02			16	$2.02	38	1.62	165	$0.70	203	.87	123	$0.98	11	1.09	134	.99
February	157	2.24	20	$2.12	177	2.23	1,899	2.80	1,616	1.92	3,515	2.40	1,595	2.38	1,044	1.68	2,639	2.10
March	428	2.93	19	2.77	447	2.92	779	2.75	280	2.17	1,059	2.60	902	2.45	349	2.50	1,251	2.46
April							9	3.12			9	3.12	1	1.45	6	1.44	7	1.44
May							10	.12			10	.12						
Total or average	601	$2.73	39	$2.44	640	$2.71	2,886	$2.67	2,061	$1.86	4,947	$2.33	2,621	$2.34	1,607	$1.68	4,228	$2.09
								1931-32										
December							116	$1.04			116	$1.04						
January							351	1.71			351	1.71	403	$1.13			403	$1.13
February	193	$1.63	106	$1 55	299	$1.60	2,640	1.37	2,415	$1.49	5,055	1.43	826	1.05	1,057	$1.49	1,883	1.30
March	121	1.82	8	1.96	129	1.83	1,021	1.97	208	1.71	1,229	1.93	1,955	1.74	301	1.54	2,256	1.71
April	4	1.80			4	1.80	1,247	2.38			1,247	2.38	1,024	2.02			1,024	2.02
May							60	.65			60	.65	35	.41			35	.41
Total or average	318	$1.70	114	$1.58	432	$1.67	5,435	$1.72	2,623	$1.51	8,058	$1.65	4,243	$1.60	1,358	$1.50	5,601	$1.58
								1932-33										
December							71	$1.04			71	$1.04	32	$0.83			32	$0.83
January	25	$1.63			25	$1.63	1,093	1.45			1,093	1.45	689	1.28	182	$1.02	871	1.23
February							1,488	1.20	302	$1.13	1,790	1.19	1,420	.74	1,004	1.11	2.424	.89
March	74	1.84			74	1.84	2,562	1.49	508	.92	3,070	1.40	812	1.09	2,359	.84	3.171	.90
April							1,837	1.32	165	.65	2,002	1.26	2,532	.73	1,824	.74	4,356	.73
Total or average	99	$1.79			99	$1.79	7,051	$1.37	975	$0.94	8,026	$1.32	5.485	$0.86	5,369	$0.86	10,854	$0.86

TABLE 24.—FLORIDA MANDARINS—MONTHLY NET RETURNS PER HALF-BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS, BY VARIETY AND GRADE *(Concluded)*.

Month Sold	Tangerines																	
	Supergrade						Grade 1						Grade 2					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return
1930-31																		
November	273	$1.75	180	$1.42	453	$1.62	20,379	$1.46	14,761	$1.38	35,140	$1.43	1,998	$1.30	9,662	$1.05	11,660	$1.09
December	4,456	1.61	1,815	1.51	6,271	1.58	35,078	1.13	17,845	1.10	52,923	1.12	3,774	1.05	8,349	.84	12,123	.91
January	2,311	1.47	702	1.02	3,013	1.37	41,645	.88	10,958	.90	52,603	.88	2,377	1.03	8,737	.68	11,114	.75
February	3,489	1.32	150	1.36	3,639	1.32	28,797	1.06	7,180	.87	35,977	1.02	2,517	1.04	13,641	.74	16,158	.79
March	1,265	1.37	63	1.23	1,328	1.36	10,030	.92	314	1.08	10,344	.92	3,766	.85	779	.86	4,545	.85
April																		
May							207	– .21			207	– .21						
Total or average	11,794	$1.47	2,910	$1.37	14,704	$1.45	136,136	$1.07	51,058	$1.11	187,194	$1.08	14,432	$1.03	41,168	$0.82	55,600	$0.88
1931-32																		
November	288	$1.51			288	$1.51	17,888	$1.50	6,719	$1.21	24,607	$1.42	5,747	$1.49	846	$0.97	6,593	$1.42
December	3,733	1.26	726	$1.21	4,459	1.25	48,506	1.04	11,693	1.13	60,199	1.06	9,481	.80	7,592	.92	17,073	.85
January	3,802	.91	1,588	1.08	5,390	.96	47,362	.86	7,439	.79	54,801	.85	14,480	.54	10,302	.62	24,782	.57
February	343	1.35	403	1.03	746	1.18	30,540	1.20	3,844	.89	34,384	1.17	16,995	.97	2,626	1.00	19,621	.97
March	143	1.48			143	1.48	3,950	1.45	114	.89	4,064	1.43	3,530	1.31	112	.86	3,642	1.30
April							335	1.56			335	1.56	344	1.05			344	1.05
May							63	.74			63	.74	96	.55			96	.55
Total or average	8,309	$1.12	2,717	$1.11	11,026	$1.11	148,644	$1.08	29,809	$1.03	178,453	$1.07	50,673	$0.90	21,478	$0.79	72,151	$0.86
1932-33																		
September-October													7	$1.28			7	$1.28
November	215	$2.08	430	$0.87	645	$1.27	10,945	$1.40	1,569	$0.81	12,514	$1.33	5,105	1.03	1,200	$0.55	6,305	.94
December	2,732	1.19	370	.93	3,102	1.16	25,273	.78	8,152	.84	33,425	.79	3,733	.71	4,853	.56	8,586	.63
January	3,321	.98	417	.79	3,738	.96	16,931	.76	9,120	.69	26,051	.74	5,178	.68	11,030	.49	16,208	.55
February	72	1.11	119	1.22	191	1.18	8,154	.70	4,314	.65	12,468	.68	6,991	.36	7,690	.61	14,681	.49
March	60	1.21	6	.76	66	1.17	9,277	.77	4,040	.55	13,317	.70	8,490	.64	10,432	.50	18,922	.56
April							906	.75			906	.75	3,263	.54			3,263	.54
Total or average	6,400	$1.11	1,342	$0.89	7,742	$1.07	71,486	$0.86	27,195	$0.71	98,681	$0.82	32,767	$0.65	35,205	$0.53	67,972	$0.59

TABLE 25.—FLORIDA MANDARINS—MONTHLY NET RETURNS PER HALF-BOX TO THE SHIPPER FOR ALL SIZES SOLD AT AUCTION IN FIVE MARKETS BY VARIETY, ALL GRADES COMBINED[1].

Month Sold	Temple						Tangerines					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return
						1930-31						
November	151	$1.12	145	$0.12	296	$0.63	22,650	$1.45	24,603	$1.25	47,253	$1.35
December			52	.53	52	.53	43,347	1.17	28,009	1.05	71,356	1.12
January	177	1.21	176	.72	353	.97	46,333	.92	20,397	.81	66,730	.89
February	3,651	2.59	2,680	1.83	6,331	2.27	34,803	1.08	20,971	.79	55,774	.97
March	2,109	2.66	648	2.36	2,757	2.59	15,061	.94	1,156	.94	16,217	.94
April	10	2.95	6	1.44	16	2.38						
May	10	.12			10	.12	207	- .21			207	- .21
Total or average	6,108	$2.53	3,707	$1.78	9,815	$2.25	162,401	$1.10	95,136	$0.99	257,537	$1.06
						1931-32						
November							23,923	$1.50	7,565	$1.19	31,488	$1.43
December	116	$1.04			116	$1.04	61,720	1.01	20,011	1.05	81,731	1.02
January	754	1.40			754	1.40	65,644	.79	19,329	.73	84,973	.78
February	3,659	1.31	3,578	$1.49	7,237	1.40	47,878	1.12	6,873	.94	54,751	1.10
March	3,705	1.72	517	1.61	4,222	1.71	7,623	1.39	226	.88	7,849	1.38
April	2,955	2.02			2,955	2.02	679	1.30			679	1.30
May	95	.56			95	.56	159	.63			159	.63
Total or average	11,284	$1.63	4,095	$1.51	15,379	$1.59	207,626	$1.04	54,004	$0.94	261,630	$1.02
						1932-33						
September-October							7	$1.28			7	$1.28
November							16,414	1.29	3,199	$0.72	19,613	1.20
December	103	$0.98			103	$0.98	31,738	.80	13,375	.74	45,113	.78
January	1,807	1.39	182	$1.02	1,989	1.36	25,529	.78	20,776	.58	46,305	.69
February	2,944	.98	1,590	.99	4,534	.98	15,258	.54	12,245	.63	27,503	.58
March	3,448	1.41	3,803	.76	7,251	1.07	17,827	.71	14,478	.52	32,305	.62
April	4,757	.93	2,010	.73	6,767	.87	4,169	.59			4,169	.59
Total or average	13,059	$1.13	7,585	$0.81	20,644	$1.01	110,942	$0.81	64,073	$0.62	175,015	$0.74

[1] Includes a small amount of Grade 3 fruit.

NET RETURNS TO THE SHIPPER ON GRADE 1 ORANGES AND GRADE 1 GRAPEFRUIT IN PERCENT OF THE NET RETURNS ON GRADE 2

An index of the net returns to the shipper on grade 1 oranges and grapefruit using grade 2 oranges and grapefruit as a base, or 100 percent, is shown in Table 26. This differs from Table 12 in that all costs of marketing have been deducted before the percentages were computed.

TABLE 26.—NET RETURNS TO THE SHIPPER ON GRADE 1 ORANGES AND GRAPEFRUIT IN PERCENT OF THE NET RETURNS ON GRADE 2.

Season	Oranges		Grapefruit	
	New York	Other Markets	New York	Other Markets
1930-31	118	119	165	140
1931-32	120	105	135	131
1932-33	140	128	171	170

Grade 1 oranges returned to the shipper from 5 to 40 percent more than grade 2 fruit over the three-season period, and grade 1 grapefruit returned from 31 to 71 percent more than grade 2 fruit. The highest premiums for both were usually in New York each of the seasons. There was a larger percentage difference in net return on grade 1 oranges and grapefruit over grade 2 in 1932-33 than in the preceding two seasons, with grade 1 grapefruit bringing a relatively higher premium over grade 2 than did oranges.

NET RETURNS TO THE GROWER FROM AUCTION SALES

Before the citrus grower gets any returns from fruit sold at auction there must be deducted from the average net returns in the foregoing tables an additional amount sufficient to cover the selling or marketing service charge made by the organization handling the fruit, and the cost of picking, hauling, and packing. The average cost per box for marketing service for the 31 packinghouses was 17.2 cents in 1930-31, 14.8 cents in 1931-32, and 14.7 cents in 1932-33.

The average packinghouse cost and the cost of picking and hauling are discussed in Bulletin 266 of the Florida Agricultural Experiment Station.[2] These costs for 125 packinghouses in

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[2] HAMILTON, H. G., and MARVIN A. BROOKER. A Study of the Cost of Handling Citrus Fruit from the Tree to the Car in Florida.

1931-32 averaged 62.5 cents per box for packing, 7.2 cents for picking, and 6.2 cents for hauling. Thus the total cost per box of picking, hauling and packing fruit in 1931-32 was 75.9 cents. If this average be assumed for 1930-31 and 1932-33 and the actual cost per box for marketing service be added, the total amount which must be deducted from net returns to the shipper to obtain the net amount which the grower received is as shown in Table 27. Although the costs of picking, hauling and packing oranges and grapefruit were not obtained separately, these costs should be somewhat higher for oranges and lower for grapefruit than the average figure shown in Table 27.

TABLE 27.—TOTAL COST OF PICKING, HAULING, PACKING, AND OF MARKETING SERVICE FOR FLORIDA CITRUS FRUIT.

Season	Cost per Box		
	Picking, Hauling, and Packing	Marketing Service	Total
1930-31	$0.759*	$0.172	$0.931
1931-32	.759	.148	.907
1932-33	.759*	.147	.906

* Assumed to be the same as in 1931-32.

The net return to the grower from auction sales of oranges and grapefruit in the five markets by the 31 packinghouses is shown for the three seasons in Table 28. This includes packed fruit only, most of which was grade 2 or above. From the grower's standpoint the 1932-33 season was the worst of the three shown.

TABLE 28.—NET RETURNS TO THE GROWER ON ORANGES AND GRAPEFRUIT SOLD AT AUCTION FROM 31 PACKINGHOUSES TO FIVE MARKETS, BY MONTHS.

Month Sold	1930-31		1931-32		1932-33	
	Oranges	Grapefruit	Oranges	Grapefruit	Oranges	Grapefruit
September-October	$2.46	$1.48	$0.52	$0.97	$0.89	$1.55
November	1.29	1.10	1.22	.75	1.29	1.18
December	1.04	.85	1.24	.43	.96	.51
January	1.01	.77	1.17	.31	.97	.48
February	1.21	.67	1.46	.24	.67	.50
March	1.78	.74	1.94	.62	.63	.31
April	1.80	.89	2.00	1.10	.49	.38
May	1.74	.48	1.70	1.64	.39	.05
June	1.80	– .16	1.63	1.74	.63	.11
July-August	1.76	– .77		1.98	1.03	.29
Season average	$1.50	$0.73	$1.59	$0.71	$0.67	$0.50

PERCENT OF THE AUCTION PRICE REPRESENTED BY NET RETURNS TO THE SHIPPER

The percent of the auction sales price which the shipper received for oranges and grapefruit sold at auction is shown in Table 29. The remainder of the selling price went to cover the cost of transportation, preservation, and the auction charge. Had the total of these costs fallen in proportion to the reduction in the price of the fruit on the auction, the shipper would have received as large a percentage of the auction price in 1932-33 as in 1930-31. This was true for grapefruit, but not for oranges.

The percentage return to the shipper for fruit sent to New York was higher than from "Other Markets" for both oranges and grapefruit and was higher on grade 1 than on grade 2 fruit.

TABLE 29.—PERCENT OF THE AUCTION PRICE WHICH NET RETURNS TO THE SHIPPER REPRESENTED.

Season	Oranges				Grapefruit			
	Grade 1		Grade 2		Grade 1		Grade 2	
	New York	Other Markets	New York	Other Markets	New York	Other Markets	New York	Other Markets
1930-31	70	67	66	63	63	59	51	51
1931-32	73	67	69	66	65	58	58	52
1932-33	67	59	61	53	65	63	53	51

Grapefruit returned a lower percentage of the auction price than did oranges. The average price for grapefruit was lower and the cost of marketing, other than the auction charge, was a fixed amount, regardless of the sales value.

TABLE 30.—PERCENT OF THE AUCTION PRICE WHICH NET RETURNS TO THE GROWER REPRESENTED.

Season	Oranges				Grapefruit			
	Grade 1		Grade 2		Grade 1		Grade 2	
	New York	Other Markets	New York	Other Markets	New York	Other Markets	New York	Other Markets
1930-31	45	41	38	33	34	27	11	12
1931-32	48	41	41	39	33	26	19	14
1932-33	34	26	19	16	31	35	5	12

The grower's share of the auction price of his fruit is shown in Table 30. From the grower's standpoint nearly all costs from the tree to the market are fixed, and his return is the sales price less these costs.

F.O.B. DIRECT AND BROKER SALES OF FLORIDA CITRUS FRUIT

The volume of citrus fruit sold f.o.b. direct and by brokers in the eight markets was very low compared with the auction sales of the same 31 packinghouses (Table 31). The importance of f.o.b. direct and broker sales from the standpoint of volume declined each season of the study so that in 1932-33 less than 100 carloads of all varieties were sold in this manner.

TABLE 31.—F.O.B. DIRECT AND BROKER SALES OF FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES TO EIGHT MARKETS.

Kind of Fruit	1930-31		1931-32		1932-33		All Seasons	
	Number of Boxes	Percent F.O.B. Sales Are of All Sales	Number of Boxes	Percent F.O.B. Sales Are of All Sales	Number of Boxes	Percent F.O.B. Sales Are of All Sales	Number of Boxes	Percent F.O.B. Sales Are of All Sales
Orranges	63,593	7.8	26,010	4.6	13,965	2.1	103,568	5.1
Grapefruit	49,958	7.0	28,120	5.5	14,189	3.1	92,267	5.5
Mandarins[1]	6,163.5	4.3	8,217	5.5	1,725	1.7	16,105.5	4.1
Total or average	119,714.5	7.2	62,347	5.1	29,879	2.5	211,940.5	5.1

[1] Converted to full boxes.

Season average prices received from f.o.b. direct and broker sales are shown in Tables 32, 33, and 34. These prices are net to shipper, as all brokerage, or selling costs, and any other charges not borne by the buyer have been deducted. These charges varied rather widely because of different terms of the sales which are included in this group.

Although the fruit which sold f.o.b. was sorted according to grade and variety for the purpose of price comparison, frequently sales of this type were made in which several grades, varieties, and sizes were loaded in one car. The buyer, instead

TABLE 32.—FLORIDA ORANGES—SEASON AVERAGE NET RETURNS PER BOX TO THE SHIPPER, ALL SIZES, IN EIGHT MARKETS, BY VARIETY AND GRADE—F.O.B. DIRECT AND BROKER SALES.

Variety and Grade	1930-31						1931-32						1932-33					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
Parson Brown:																		
Grade 1			1,333	$3.24	1,333	$3.24			360	$2.11	360	$2.11			360	$2.00	360	$2.00
Grade 2			912	2.85	912	2.85												
All grades			2,245	$3.08	2,245	$3.08			360	$2.11	360	$2.11			360	$2.00	360	$2.00
Pineapple:																		
Grade 1	1,604	$1.58	1,903	$1.89	3,507	$1.75	1,772	$2.11	1,324	$1.82	3,096	$1.99	901	$2.51	675	$2.00	1,576	$2.29
Grade 2	371	1.53	372	1.61	743	1.57			2,219	1.94	2,219	1.94	1,011	1.65	1,011	1.68	2,022	1.66
Grade 3															314	1.36	314	1.36
All grades	1,975	$1.57	2,275	$1.85	4,250	$1.72	1,772	$2.11	3,543	$1.90	5,315	$1.97	1,912	$2.06	2,000	$1.74	3,912	$1.89
Valencia:																		
Grade 1	18,167	$2.66	11,499	$2.64	29,666	$2.65	6,679	$2.85	2,123	$3.02	8,802	$2.89			2,029	$1.34	2,029	$1.34
Grade 2	10,625	2.41	5,176	2.31	15,801	2.38	64	2.60	2,432	3.00	2,496	2.99			1,230	1.17	1,230	1.17
Grade 3									304	2.17	304	2.17			2,616	1.30	2,616	1.30
All grades	28,792	$2.57	16,675	$2.54	45,467	$2.56	6,743	$2.85	4,859	$2.95	11,602	$2.89			5,875	$1.29	5,875	$1.29
Other varieties:																		
Supergrade															79	$0.47	79	$0.47
Grade 1	2,455	$1.99	5,246	$2.23	7,701	$2.15	2,779	$2.25	2,824	$2.22	5,603	$2.24			615	1.38	615	1.38
Grade 2	1,722	1.58	1,848	1.81	3,570	1.70			2,957	1.83	2,957	1.83	760	$1.43	2,364	1.22	3,124	1.27
Grade 3			360	2.06	360	2.06			173	1.20	173	1.20						
All grades	4,177	$1.82	7,454	$2.12	11,631	$2.01	2,779	$2.25	5,954	$2.00	8,733	$2.08	760	$1.43	3,058	$1.23	3,818	$1.27
All varieties:																		
Supergrade															79	$0.47	79	$0.47
Grade 1	22,226	$2.51	19,981	$2.50	42,207	$2.50	11,230	$2.59	6,631	$2.39	17,861	$2.51	901	$2.51	3,679	1.53	4,580	1.73
Grade 2	12,718	2.28	8,308	2.23	21,026	2.26	64	2.60	7,608	2.24	7,672	2.24	1,771	1.56	4,605	1.31	6,376	1.38
Grade 3			360	2.06	360	2.06			477	1.82	477	1.82			2,930	1.31	2,930	1.31
All grades	34,944	$2.42	28,649	$2.42	63,593	$2.42	11,294	$2.59	14,716	$2.29	26,010	$2.42	2,672	$1.88	11,293	$1.38	13,965	$1.47

TABLE 33.—FLORIDA GRAPEFRUIT—SEASON AVERAGE NET RETURNS PER BOX TO THE SHIPPER, ALL SIZES, IN EIGHT MARKETS, BY VARIETY AND GRADE—F.O.B. DIRECT AND BROKER SALES.

Variety and Grade	1930-31						1931-32						1932-33					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return	Boxes	Net Return
Marsh Seedless:																		
Supergrade									8	$1.20	8	$1.20						
Grade 1	360	$1.77	12,147	$2.09	12,507	$2.08	777	$2.53	6,138	1.86	6,915	1.94			2,215	$1.39	2,215	$1.39
Grade 2			4,309	1.68	4,309	1.68			4,264	1.74	4,264	1.74			4,161	1.03	4,161	1.03
Grade 3			2,568	1.48	2,568	1.48			1,132	1.59	1,132	1.59			766	.95	766	.95
All grades	360	$1.77	19,024	$1.92	19,384	$1.91	777	$2.53	11,542	$1.79	12,319	$1.84			7,142	$1.13	7,142	$1.13
Other varieties:																		
Supergrade	131	$3.15			131	$3.15												
Grade 1	4,041	1.54	13,052	$1.61	17,093	1.60	1,460	$2.03	4,654	$1.69	6,114	$1.77	360	$1.97	2,071	$2.25	2,431	$2.21
Grade 2	1,133	1.43	11,857	1.23	12,990	1.25	110	.77	8,658	1.50	8,768	1.49	360	1.72	4,000	1.33	4,360	1.36
Grade 3			360	1.08	360	1.08			919	1.57	919	1.57			256	2.00	256	2.00
All grades	5,305	$1.55	25,269	$1.43	30,574	$1.45	1,570	$1.94	14,231	$1.56	15,801	$1.60	720	$1.85	6,327	$1.66	7,047	$1.68
All varieties:																		
Supergrade	131	$3.15			131	$3.15			8	$1.20	8	$1.20						
Grade 1	4,401	1.56	25,199	$1.84	29,600	1.80	2,237	$2.20	10,792	1.79	13,029	1.86	360	$1.97	4,286	$1.80	4,646	$1.82
Grade 2	1,133	1.43	16,166	1.35	17,299	1.36	110	.77	12,922	1.58	13,032	1.57	360	1.72	8,161	1.18	8,521	1.20
Grade 3			2,928	1.43	2,928	1.43			2,051	1.58	2,051	1.58			1,022	1.21	1,022	1.21
All grades	5,665	$1.57	44,293	$1.64	49,958	$1.63	2,347	$2.13	25,773	$1.44	28,120	$1.50	720	$1.85	13,469	$1.38	14,189	$1.40

TABLE 34.—FLORIDA TANGERINES—SEASON AVERAGE NET RETURNS PER HALF-BOX TO THE SHIPPER, ALL SIZES, IN EIGHT MARKETS, BY GRADE—F.O.B. DIRECT AND BROKER SALES.

Grade	1930-31						1931-32						1932-33					
	New York		Other Markets		All Markets		New York		Other Markets		All Markets		New York		Other Markets		All Markets	
	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return	Half-Boxes	Net Return
Supergrade									7	$1.90	7	$1.90			30	$1.40	30	$1.40
Grade 1			1,619	$2.31	1,619	$2.31			4,587	.98	4,587	.98			2,433	.95	2,433	.95
Grade 2			10,170	.82	10,170	.82			11,840	.64	11,840	.64			987	.54	987	.54
Grade 3			538	1.61	538	1.61												
All grades			12,327	$1.05	12,327	$1.05			16,434	$0.74	16,434	$0.74			3,450	$0.84	3,450	$0.84

TABLE 35.—FLORIDA ORANGES—SEASON AVERAGE PRICES PER BOX IN EIGHT MARKETS, BY VARIETY AND SIZE—F.O.B. DIRECT AND BROKER SALES.

Size	Parson Brown						Pineapple						Valencia					
	1930-31		1931-32		1932-33		1930-31		1931-32		1932-33		1930-31		1931-32		1932-33	
	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price
100	.1	$4.00					.3	$1.64	.2	$3.00	.2	$1.88	.5	$2.58	1.7	$2.31	.4	$1.63
126	1.4	3.84					1.5	1.78	1.3	2.67	3.0	2.34	19.2	2.59	10.1	2.66	11.6	1.89
150	3.3	4.07	3.1	$2.36			6.0	2.00	4.7	2.66	5.9	2.28	31.3	2.65	20.8	2.98	11.0	2.02
176	12.7	3.81	30.3	2.35			12.9	2.14	9.9	2.56	15.6	2.21	27.9	2.69	25.0	3.09	15.3	2.10
200	10.0	3.58	29.4	2.35			22.4	2.02	13.5	2.39	17.2	2.19	11.1	2.73	12.1	3.16	14.0	2.09
216	26.7	3.44	37.2	2.35	35.0	$2.25	33.7	2.03	21.1	2.33	25.5	2.09	7.9	2.75	12.7	3.14	17.3	2.10
250	22.6	3.02			65.0	2.25	16.6	2.11	19.3	2.15	13.9	1.95	1.3	2.90	10.4	3.16	15.7	2.06
288	16.7	3.14					5.6	2.11	19.6	2.04	10.8	1.94	.5	2.91	5.7	3.07	10.6	2.00
324	6.3	2.84					1.0	2.49	10.4	2.01	7.9	2.05	.1	2.81	1.5	2.71	4.0	1.95
Other	.2	3.00					*	3.00					.2	2.72			.1	1.60
All sizes	100.0	$3.34	100.0	$2.35	100.0	$2.25	100.0	$2.06	100.0	$2.25	100.0	$2.11	100.0	$2.67	100.0	$3.03	100.0	$2.04
Number of boxes sold	2,245		360		360		4,250		5,315		3,912		45,467		11,602		5,875	

Size	Other Varieties						All Varieties					
	1930-31		1931-32		1932-33		1930-31		1931-32		1932-33	
	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price
100	.1	$1.90	.1	$2.33	.1	$2.00	.4	$2.52	.9	$2.35	.3	$1.71
126	2.9	2.58	1.7	2.39	1.8	1.73	14.4	2.59	5.3	2.63	6.2	1.94
150	6.2	2.48	4.7	2.42	4.2	1.89	24.0	2.64	11.8	2.88	7.4	2.06
176	14.9	2.22	11.8	2.53	8.7	1.85	23.9	2.64	17.6	2.88	13.2	2.09
200	16.5	2.18	12.0	2.59	11.0	1.84	12.8	2.54	12.6	2.79	13.7	2.07
216	21.4	2.14	16.7	2.52	26.7	1.75	12.8	2.48	16.1	2.68	22.6	1.99
250	20.7	2.26	17.4	2.20	20.9	1.81	6.7	2.42	14.4	2.49	17.9	1.97
288	11.6	2.40	18.5	1.92	18.6	1.51	3.4	2.54	12.8	2.18	12.6	1.79
324	2.7	2.23	9.8	1.80	8.0	1.06	.9	2.46	6.1	1.97	6.1	1.66
Other	3.0	2.35	7.3	2.70			.7	2.44	2.4	2.70	*	1.60
All sizes	100.0	$2.26	100.0	$2.30	100.0	$1.69	100.0	$2.58	100.0	$2.61	100.0	$1.97
Number of boxes sold	11,631		8,733		3,818		63,593		26,010		13,965	

*Less than one-tenth of 1 percent.

TABLE 36.—FLORIDA GRAPEFRUIT—SEASON AVERAGE PRICES PER BOX IN EIGHT MARKETS, BY VARIETY AND SIZE—F.O.B. DIRECT AND BROKER SALES.

Size	Marsh Seedless						Other Varieties						All Varieties					
	1930-31		1931-32		1932-33		1930-31		1931-32		1932-33		1930-31		1931-32		1932-33	
	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price
36	.1	$2.10	.6	$2.08	.2	$1.91	1.5	$1.59	2.0	$1.72	.8	$2.47	.9	$1.60	1.4	$1.79	.5	$2.38
46	3.3	1.84	3.1	2.09	.9	1.72	14.7	1.59	6.3	1.68	3.3	2.10	10.3	1.62	4.9	1.79	2.1	2.02
54	13.1	2.06	11.8	2.15	7.3	1.83	31.6	1.55	18.7	1.81	16.0	1.94	24.4	1.66	15.7	1.92	11.7	1.90
64	20.5	2.11	15.4	2.08	7.0	1.86	21.7	1.66	19.3	1.94	17.6	1.91	21.2	1.83	17.6	1.99	12.2	1.89
70	22.3	2.11	22.3	2.12	10.5	1.82	16.0	1.74	20.1	2.01	18.1	1.89	18.4	1.91	21.0	2.06	14.3	1.86
80	26.3	2.11	17.6	2.19	28.3	1.73	11.1	1.84	24.9	1.80	26.4	1.91	17.0	2.01	21.7	1.93	27.3	1.82
96	12.3	2.04	24.1	1.89	35.9	1.80	2.9	1.71	7.3	1.78	14.5	2.06	6.6	1.95	14.6	1.86	25.2	1.87
100	.1	2.04	.1	1.53	1.1	1.63							.1	2.04	.1	1.53	.6	1.63
126	2.0	1.94	5.0	1.80	8.8	1.90	.2	1.64	1.4	1.71	1.5	2.14	.9	1.90	3.0	1.78	5.2	1.93
Other							.3	1.00	*	1.29	1.8	1.22	.2	1.00	*	1.29	.9	1.22
All sizes	100.0	$2.08	100.0	$2.05	100.0	$1.79	100.0	$1.64	100.0	$1.86	100.0	$1.93	100.0	$1.82	100.0	$1.94	100.0	$1.86
Number of boxes sold	19,384		12,319		7,142		30,574		15,801		7,047		49,958		28,120		14,189	

*Less than one-tenth of 1 percent.

of offering a separate price for each classification, simply rounded off or averaged his offer per box for the agreed proportion of each grade, variety and size. This should be kept in mind in making comparisons, since it tends to lessen any differences which would otherwise appear for different grades and sizes had the buyer always bid on each separately as in auction sales.

Because of the scattered nature of shipments of f.o.b. direct and broker sales, the monthly price series is incomplete. Also it is difficult to draw conclusions from this type of sale, on account of the weaknesses mentioned above. However, the net amount per box which the shipper received from fruit sold f.o.b. showed the same general price trend each season as the net return on auction sales for both oranges and grapefruit. Usually there was no great difference in the net amount per box received for oranges sold in New York and in the "Other Markets". Grapefruit returns varied rather widely between markets, being at times higher in New York and at other times higher in "Other Markets.". This difference in price, apparently between markets, is probably due primarily to differences in date of sale.

TABLE 37.—FLORIDA TANGERINES—SEASON AVERAGE PRICES PER HALF-BOX IN EIGHT MARKETS, BY VARIETY AND SIZE—F.O.B. DIRECT AND BROKER SALES.

Size	1930-31		1931-32		1932-33	
	Percent of Total	Price	Percent of Total	Price	Percent of Total	Price
90	*	$1.00				
106	.2	1.00	.6	$0.82		
120	6.9	1.21	6.9	.91	.9	$2.47
144	18.7	1.39	13.2	.96	3.9	1.90
168	24.5	1.43	17.9	.86	13.7	1.53
196	16.0	1.17	18.7	.82	11.8	1.24
216	10.1	1.03	16.6	.79	13.3	.95
224	5.5	1.10	2.1	.72		
250	17.1	1.08	12.1	.78	26.7	.87
Other	1.0	.79	11.9	.98	29.7	.70
All sizes	100.0	$1.24	100.0	$0.86	100.0	$1.02
Number of half-boxes sold	12,327		16,434		3,450	

*Less than one-tenth of 1 percent.

SIZE DISTRIBUTION BY VARIETY, AND SEASON AVERAGE PRICE FOR EACH SIZE

The size distribution and weighted average price for each size of Florida oranges, grapefruit, and tangerines sold f.o.b. are shown in Tables 35, 36, and 37. The prices shown are the gross sales price before deducting selling charges. The percent of the total which each size represents is in general similar to that for auction sales.

The average difference in the price received for the most desirable and least desirable sizes was somewhat smaller for all oranges and all grapefruit sold f.o.b. direct or by broker, than for auction sales.

SUMMARY

This study is based upon citrus shipments from 31 Florida packinghouses to New York, Chicago, Detroit, Cincinnati, and Pittsburgh for auction sales; and to three additional markets for f.o.b. direct and broker sales, viz., Minneapolis, Kansas City, and New Orleans. Shipments extend through the three-season period 1930-31 to 1932-33, and include sales of about 11,000 carloads of packed fruit which moved by rail and by boat.

Auction sales greatly predominated, making up almost 95 percent of the total auction and f.o.b. sales for the three seasons (Table 30). Approximately one-half the auction sales were oranges, 40 percent grapefruit, and 10 percent Mandarins—mainly Temple and tangerines (Table 1).

The price per box for oranges usually was somewhat higher on the New York auction than the average of the other auctions when the same grades and varieties were compared. Exceptions to this are noted during the 1932-33 season when the other markets were as high as New York (Table 2).

The three-season weighted average price of oranges, by varieties, in the five markets was highest for Parson Brown which brought $3.56 per box compared with an average of $3.37 per box for Valencia, $3.26 per box for Pineapple, and $2.95 per box for other varieties. The rank in order of the auction price is not the same each season, being dependent upon the price trend of that season (see also Table 3 and Figs. 4, 5, 6, and 7).

The price of supergrade oranges on the five auctions was consistently above the price of grade 1, averaging for the three seasons 54 cents per box higher and the price of grade 1 oranges exceeded the price of grade 2 oranges by an average of 42 cents per box (Table 4). The premium on grade 1 oranges ranged from 11 percent to 27 percent above the price of grade 2 (Table 12).

In 1930-31 and 1931-32 the auction prices of grapefruit were usually higher in New York than in the "Other Markets", especially for high grade fruit. In 1932-33 auction prices in "Other Markets" were usually higher (Table 5).

With few exceptions Marsh Seedless grapefruit brought higher prices than "Other Varieties" (Tables 5 and 6 and Figs. 13, 14, and 15). The three-season weighted average price of Marsh Seedless on the five auctions was $2.80 per box compared with $2.60 per box for "Other Varieties". However, this is less reliable as a measure of market preferences than monthly comparisons within the same grade and market, because of the differences in the seasonal distribution of Marsh Seedless and "Other Varieties" (See Tables 5 and 6).

The premium paid for supergrade grapefruit on the five auctions over grade 1 averaged 40 cents per box for the three seasons, with grade 1 bringing an average of 62 cents per box more than grade 2 (Table 7). The percentage premium of grade 1 fruit ranged from 17 percent to 39 percent above grade 2 for all varieties of grapefruit (Table 12).

New York received a higher proportion of high grade fruit and a lower proportion of low grade fruit than the "Other Markets". For the three seasons, New York received 70.4 percent of the oranges sold on the five auctions, compared with 95.1 percent of the supergrade, and 79 percent of the grade 1 oranges. For the same period 59.4 percent of the grapefruit went to New York compared with 88.1 percent of the supergrade and 67.9 percent of the grade 1 grapefruit (Tables 10 and 11).

The three-season average grade distribution for all varieties of oranges was 5.6 percent supergrade, 56.9 percent grade 1, 36.6 percent grade 2, and 0.9 percent grade 3. For all varieties of grapefruit there was 3.4 percent supergrade, 54.4 percent grade 1, 40.9 percent grade 2, and 1.3 percent grade 3 (Table 13).

The difference in the three-season weighted average price paid on the five auctions between the most desirable and the least desirable size was 92 cents per box for oranges, 80 cents per box for grapefruit, and 34 cents per half-box for tangerines. Sizes averaging the highest price for the three seasons were oranges, 176; grapefruit, 46; tangerines, 90 (Tables 14, 15, and 16; Figs. 20, 24, and 28). Variations in the size bringing the highest price for each variety, by seasons are shown in Figs. 21, 22, 23, 25, 26, and 27.

The total cost per box for freight, refrigeration and precooling, auction selling, and other miscellaneous charges while enroute to market declined from an average of $1.14 in 1930-31 to $1.04 in 1931-32, and 97 cents in 1932-33. Most of the reduction in costs applied only to the New York market, and was obtained by the increased use of water transportation upon which rates were considerably lower than for rail. Total costs of marketing in the other markets remained almost constant throughout the three-year period (Table 17 and Fig. 29).

After deducting all costs of getting the fruit from the packinghouse to the market, including auction selling, the shipping agency received from auction sales in the five markets an average of $2.43 per box for oranges in 1930-31, $2.50 per box in 1931-32, and $1.58 per box in 1932-33 (Table 19). Grapefruit returned an average of $1.66 per box in 1930-31, $1.62 in 1931-32, and $1.41 in 1932-33 (Table 22). Variations between varieties, grades, and markets are shown in Tables 18, 20, 21, 23, 24, and 25.

From the grower's standpoint the 1932-33 season was the worst of the three studied. Net returns on all varieties of oranges to the grower averaged $1.50 per box in 1930-31, $1.59 in 1931-32, and 67 cents in 1932-33. Grapefruit returned an average of 73 cents per box in 1930-31, 71 cents per box in 1931-32, and 50 cents per box in 1932-33 (Table 28). Only packed fruit which sold at auction, mostly of grade 2 and better, is included in this calculation.

F.o.b. direct and broker sales comprised only 5.1 percent of the total auction and f.o.b. sales from the 31 packinghouses to the eight markets during the three seasons (Table 30).

APPENDIX

Copies of the punch cards used in this study are shown in Figs. 1 and 2. The card shown in Fig. 1 was designed to carry the price information, with a separate card for each kind, variety, grade and color of fruit within a given car or boat shipment.

The cards were electrically sorted and tabulated on Hollerith machines by the punched holes which represented figures. In the first 21 columns these figures were punched in code. For example, in column 19 (variety), 1 represented Parson Brown, 2 represented Pineapple, and 3 represented Valencia oranges, thus making it possible to separate varieties by sorting according to the punched holes in column 19.

In columns 22 to 80 the number of boxes and the value to the nearest even dollar of each size of fruit were punched.

All charges against the fruit from the packinghouse—including ice and pre-cooling, if used—to the market, including selling, were punched in cards of the type shown in Fig. 2. Only one card was required for each carload shipped, with the coded data being punched in the first 17 columns.

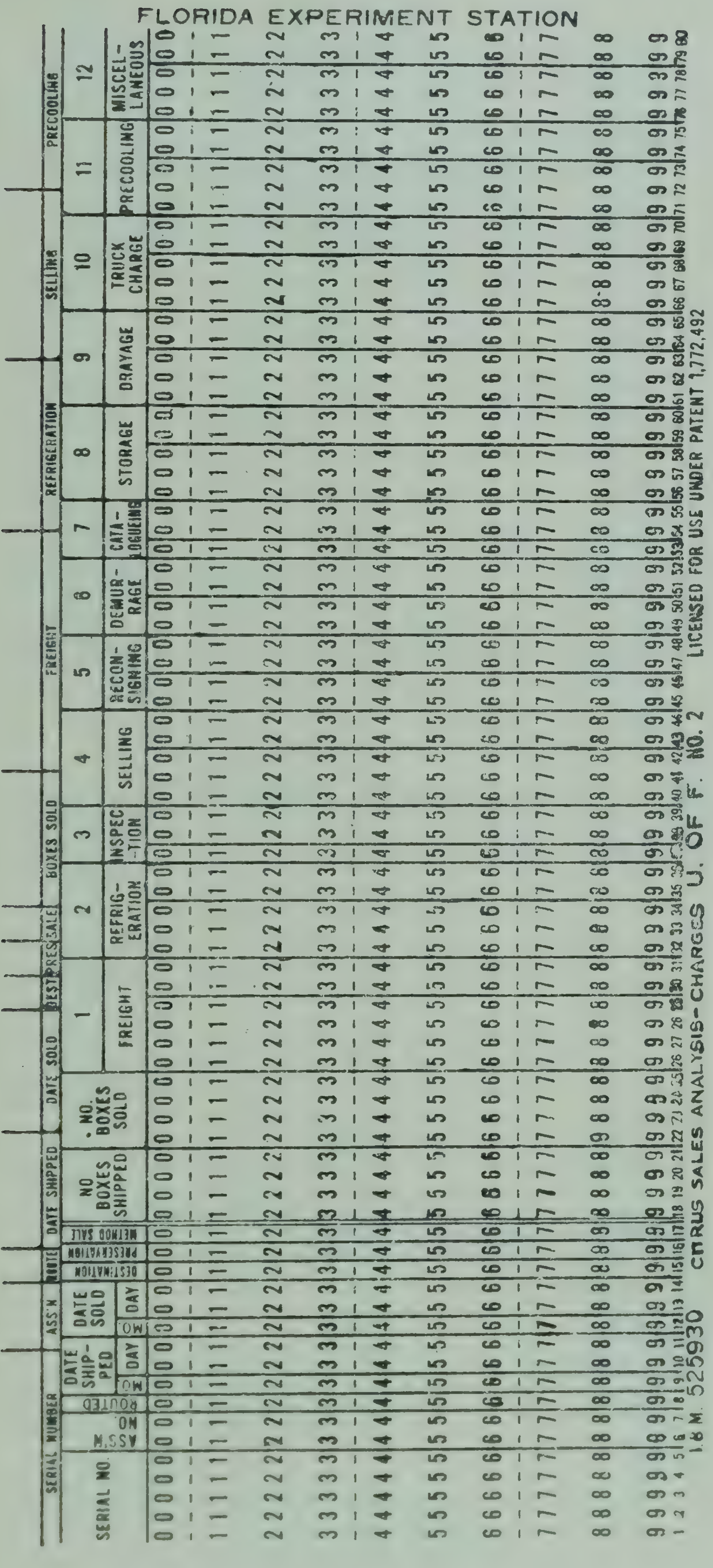

Fig. 1.—Outline of punch card used in tabulating citrus price data.

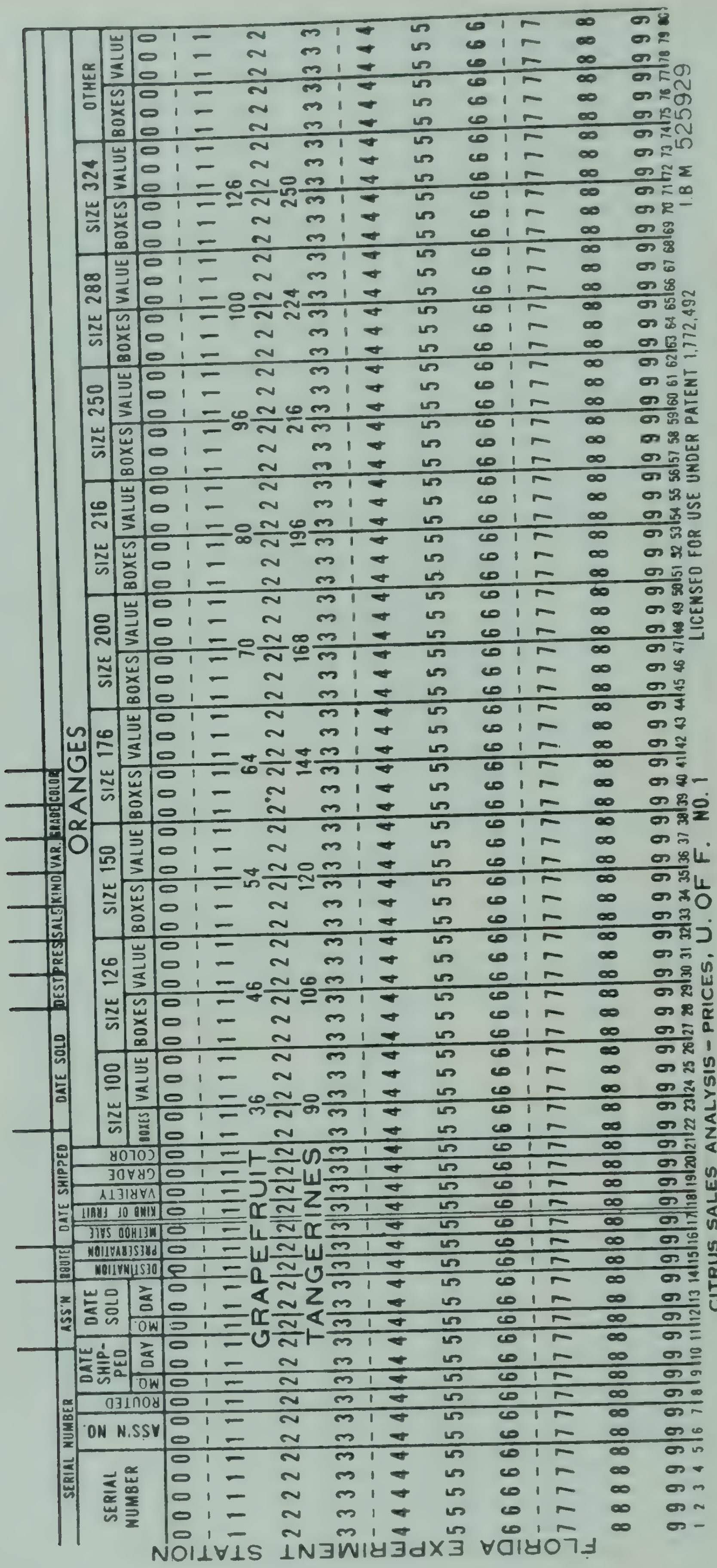

Fig. 2.—Outline of punch card used in tabulating charges against citrus fruit from the packinghouse to the market.

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AGRICULTURAL EXPERIMENT STATION
GAINESVILLE, FLORIDA
WILMON NEWELL, Director

27/5

COLD STORAGE STUDIES OF FLORIDA CITRUS FRUITS

III. The Relation of Storage Atmosphere to the Keeping Quality of Citrus Fruit in Cold Storage

By

ARTHUR L. STAHL AND JOHN C. CAIN

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THE RELATION OF STORAGE ATMOSPHERE TO THE KEEPING QUALITY OF CITRUS FRUIT IN COLD STORAGE

By ARTHUR L. STAHL AND JOHN C. CAIN

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Since medical and nutritional scientists have stressed the importance in the human diet of vitamins, enzymes, hormones, mineral elements and other substances essential to growth and health, which are found in greatest abundance in fresh food products, investigators have, within the past decade, concentrated their efforts on methods of keeping food products as long as possible in the fresh condition. The most widely used method for extending the time in which produce remains fresh after harvesting is cold storage.

In Florida fresh citrus fruit has been marketed to a greater or lesser extent throughout the year with the aid of early and late varieties and cold storage facilities but the demand for this produce during the "out of season" period from May to September warrants further investigation in methods of storing.

There is a vast loss from various forms of deterioration after two or three months in cold storage. Various improved methods of treating and storing citrus fruit (*15, 16*)[1] have tremendously decreased this loss of fruit during storage but it still remains an important problem to the citrus industry.

In previous work on cold storage of citrus fruit, it was observed that storage atmosphere played an important role in keeping the proper physiological balance within the fruit, which must be maintained in order to keep the fruit in best condition.

The causes of deterioration during and after storage are both pathological and physiological. Pathological deterioration is caused by fungi and bacteria attacking the fruit and causing subsequent decay. These may be reduced either by preventing the original infection or by inhibiting later growth of the organisms. The primary concern in this investigation is with physiological deterioration, which often is a combination of many things intimately related to the catabolism of the fruit.

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[1] Italic figures in parentheses refer to "Literature Cited" in the back of this bulletin.

That the reader may understand more clearly the forthcoming experimental data and the discussion thereof, it is thought best to give here a brief discussion of the fundamental physiology concerned.

The orange, or any other fruit, is a living plant part even after it is picked from the tree. It is capable of carrying on the life processes, to a certain extent, as it did when still attached to the living plant. In fact, its catabolic activities are even greater because it must maintain its life entirely on the food products stored within the fruit (sugars, acids, proteins, oils, etc.). Hence, the metabolic activity is entirely a destructive one—catabolism. This includes respiration, which is the chemical process of breaking down these organic food materials with a release of energy which is used to maintain life; transpiration, which is the elimination of the water evolved during these respiratory reactions; and the other physical and chemical changes taking place during the destructive life process. The fruit is of greatest value when it contains the most food elements, yet this process of catabolism is destroying much of the food value which we wish to preserve. The object, then, is to slow down this process as much as possible, to prevent loss of food value, and still maintain the fresh condition of the fruit as long as possible.

Oxygen is necessary for normal respiration, but this cannot be cut off entirely because anaerobic (abnormal) respiration then takes place, with the production of toxic by-products that endanger the life of the fruit. Also, the by-products of aerobic (normal) respiration (mostly CO_2 and H_2O) must be eliminated. These normally pass off into the surrounding atmosphere in the form of gases and vapors. Since the O_2 necessary for normal respiration comes from the atmosphere and the waste, or by-products, are eliminated into the atmosphere, it is readily seen that, in a small closed system, such as an ordinary cold storage room, the atmosphere would soon become contaminated with waste products and deficient in the life maintaining elements. This is unfavorable in maintaining proper life balance, producing, in most stored fruit and vegetables, the well known "stored" flavor.

Since the atmosphere plays such an important role in this phase of food preservation, these investigations were begun.

The object of these investigations was threefold: First, to further the knowledge pertaining to the preservation of fresh citrus fruit for as long a time as possible in good marketable condition with a minimum of decay and physiological deterioration; second, to retain the flavor, taste, appearance and quality near to that of the freshly harvested fruit; third, to study the fundamental physiological response of the fruit in various storage atmospheres and the physiology of deterioration in storage.

PREVIOUS INVESTIGATIONS

In recent years many investigations have been reported on air conditioning, gas storage and treatment of fresh fruit and vegetables with various gases in order to lengthen the storage period. As early as 1821, Berard (*3*), according to Eaves (*6*), showed that the storage life of fruits could be lengthened by storage in an atmosphere devoid of oxygen but little or no interest was taken in the work until early in the twentieth century. Gore and Fairchild (*7*) in 1911 showed the effect of carbon dioxide and alcohol vapors on reducing astringency of Japanese persimmons and Overholser (*13*) in 1927 checked this work, showing the same results, but included treatments with ethylene gas and ethylene compounds. These reduced astringency but also produced rapid softening and ripening. Davis and Church (*5*) in 1931 showed that ethylene increased respiratory activity and the sugar content, accompanied by softening and ripening, of Japanese persimmons.

Bartholomew (*1*) in his study of black heart of potato, showed this disease to be a toxic condition caused by a lack of oxygen. Bennett and Bartholomew (*2*) further showed how respiratory activity of potatoes decreases in an atmosphere devoid of oxygen and also with a decrease in temperature. Smith (*14*) showed that the respiration of dormant potato tubers increased when treated with ethylene chlorhydrin. The alcoholic content of oranges stored in high concentrations of CO_2 was found by Onslow and Barker (*12*) to be much higher than of those stored in ordinary air.

Many widely varying effects have been noted in fresh products as a result of variations in the constituents of the atmosphere. Eaves (*6*) in 1934 showed a deleterious effect of N_2 gas on strawberries and found that high concentrations of CO_2 decreased "sweating", softening, and mold growth. CO_2 also maintained the bright appearance of raspberries and strawberries, but produced a bitter flavor. He recommends a maximum of 10% CO_2 in the storage atmosphere, with best results for maintenance of flavor at 5% CO_2.

In studying the chemical changes taking place during storage of fruits, Kidd and West (*9*) found that increased concentrations of CO_2 retarded the loss of carbohydrates and alcohol-insoluble material, and accelerated the loss of acid and the hydrolysis of cane sugar.

Nelson (*11*) produced "brown spot" or storage spot (more commonly called "pitting") of citrus fruit with storage in an atmosphere of N_2 gas and also with a continuous stream of air circulated over the fruit in a closed container. He suggested that this condition is caused by a lack of O_2. He also showed in other experiments that this same condition was produced by exposure of the fruit to the vapors of citral, citronellal and various acetates, and suggested further that any substance having a similar action may accentuate storage injury of citrus fruit.

Thornton (*18*) showed that Valencia oranges could withstand a concentration of 50% to 60% of CO_2 for as long as seven days without injury and that the opening of rosebuds could be delayed several days by small amounts of CO_2 gas (*17, 18*). In further work (*19*) on CO_2 gas storage, he showed that the oxygen uptake by potatoes, onions and beets was increased by high concentrations of CO_2 gas and that of strawberries, bananas and tulip bulbs was reduced by high concentrations of the gas in the storage atmosphere.

There are numerous other works (*4, 10*, and others) showing effects of atmospheric variations on the physical and chemical changes taking place during the storage of fresh produce.

The investigations reported here were carried out over several seasons and will be presented in chronological order.

PRELIMINARY EXPERIMENTS

In order to get some idea of the reaction of citrus fruits stored under a large variety of atmospheric conditions and because of the limited equipment and material available, these preliminary investigations were necessarily undertaken on a small scale. Ordinary laboratory desiccators were used as containers for the fruit.

Because of the individual variations and the limited number of fruit used in these preliminary experiments, several repetitions of the work were made, using the same and other varieties of citrus, and the results used only as a guide to further experimentation on a larger scale. Results with Silver Cluster grapefruit are reported as preliminary experiments. Results from experiments in which a large number of fruit were used, were the basis for the conclusions drawn from this investigation.

The effects of several different atmospheric conditions on the texture, taste, loss of weight and amount of pitting of Silver Cluster grapefruit were observed, since this fruit had been found from earlier storage experiments to be very sensitive to storage conditions. In this experiment the fruit was carefully picked (from the Experiment Station grove) and washed so that pitting and other changes on the surface might be more easily observed. This fruit was then divided into 14 lots, the sizes being selected so that each lot had approximately the same sizes of fruit. Then a 12-inch desiccator, equipped as

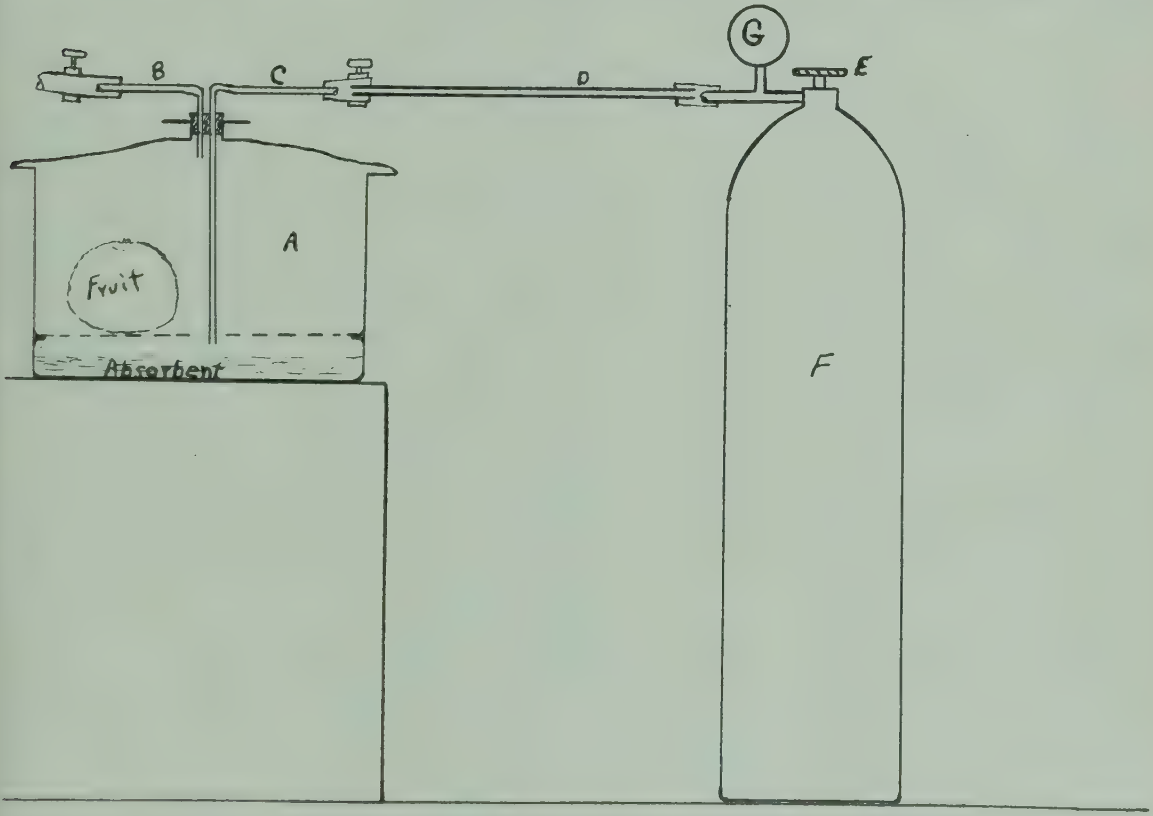

Fig. 1.—Diagram of one of the desiccators used in Experiment 1, showing how the gas was supplied.

A—Sealed desiccator containing fruit and absorbent.
B—Outlet tube with rubber nipple and screw-clamp for sealing.
C—Inlet tube with rubber nipple and screw-clamp through which the gas from the cylinder (F) enters the desiccator.
D—Glass tube used for connecting cylinder to desiccator.
E—Valve to cylinder by which the flow of gas was regulated.
F—Compressed gas cylinder.
G—Gauge to indicate the pressure of the air going into the desiccator.

shown in Fig. 1, was prepared for each lot as follows and numbered consecutively from 1 through 14.

Nos. 1 through 5 contained one liter each of concentrated H_2SO_4 (sulfuric acid)
Nos. 6 through 9 contained one liter each of 10% KOH (potassium hydroxide)
Nos. 10 through 14 were checks, no absorbent

All desiccators, with their respective solutions, and fruit supported over the absorbing solution by a perforated porcelain disc, were placed in a storage room at 37° F. This temperature was selected because previous investigations (*15*) have shown it to be the most favorable for storage of citrus fruits. The fruits in each desiccator were numbered by their positions in the desiccator and weighed individually every two weeks and the previously mentioned observations were recorded.

Immediately after placing the fruit in storage, the atmospheres in the desiccators were flushed with the following gases, respectively:

Nos. 1, 6 and 10	nitrogen gas
Nos. 2, 7 and 11	oxygen gas
Nos. 3, 8 and 12	hydrogen gas
Nos. 4 and 13	carbon dioxide gas
Nos. 5, 9 and 14	ordinary air

The gases were supplied through the inlet tubes extending to the bottom of the desiccators, replacing the air within the desiccators which escaped through the other (outlet) tubes (Fig. 1). The lids of the desiccators were sealed air-tight with vaseline, short pieces of rubber tubing and screw clamps being used to close the inlet and outlet tubes sealed in the rubber stoppers with paraffin. Paraffin also sealed the rubber stoppers into the desiccator lids. The atmospheres of the desiccators were flushed every two days with the gases as indicated above. The gases were supplied from commercial compressed gas cylinders, being allowed to flow from three to four minutes under five pounds pressure through the desiccators.

The recorded data are compiled in Tables 1 and 2.

The taste and texture are shown only at the end of 22 weeks in storage. Fig. 2 is a graphical representation of the loss of weight data shown in Table 1.

Upon examination, the data in Table 1 show a tremendous increase in loss of weight from fruit stored in all the gases used with H_2SO_4 as an absorbent over those used with KOH or with no absorbent. This, of course, was due to the dehydrating effect of the H_2SO_4 on the atmosphere, the effect of which was not phenomenal at all but shows the flexibility of the loss of weight.

TABLE 1.—LOSS IN WEIGHT IN GRAMS AND PERCENT OF SILVER CLUSTER GRAPEFRUIT STORED AT 37° F. IN ATMOSPHERES OF VARIOUS GASES.
(Averages of four fruits)

Treatment		After 2 Wks.		After 4 Wks.		After 6 Wks.		After 8 Wks.		After 10 Wks.		After 12 Wks.		After 14 Wks.	
Absorbing Agent	Gas	Loss in gms.	Per-cent Loss	Loss in gms.	Per-cent Loss	Loss in gms.	Per-cent Loss	Loss in gms.	Per-cent Loss	Loss in gms.	Per-cent Loss	Loss in gms.	Per-cent Loss	Loss in gms.	Per-cent Loss
H_2SO_4	N_2	4.3	1.18	9.1	2.50	13.8	3.79	17.1	4.69	19.7	5.40	24.9	6.83	30.8	8.45
“	O_2	5.9	1.62	11.3	3.11	16.4	4.52	19.1	5.26	22.1	6.08	26.2	7.21	32.3	8.89
“	H_2	6.1	1.53	12.9	3.23	19.4	4.85	23.1	5.78	24.8	6.21	32.3	8.08	38.8	9.71
“	CO_2	4.2	1.11	9.6	2.55	14.2	3.76	16.7	4.43	18.1	4.80	22.9	6.07	28.1	7.45
“	Air	6.3	1.66	11.5	3.04	16.0	4.23	19.3	5.10	21.8	5.76	26.6	7.03	33.1	8.75
KOH	N_2	1.0	0.25	1.1	0.28	1.1	0.28	1.1	0.28	1.1	0.28	1.2	0.30	1.4	0.35
“	O_2	0.6	0.15	1.3	0.32	1.3	0.32	1.4	0.35	1.4	0.35	1.4	0.34	2.0	0.48
“	H_2	0.5	0.13	1.5	0.38	1.6	0.41	1.8	0.46	2.0	0.51	2.0	0.50	2.4	0.59
“	Air	0.6	0.16	1.3	0.38	1.5	0.40	1.7	0.45	2.4	0.64	2.7	0.72	2.8	0.75
None	N_2	1.3	0.34	1.4	0.37	1.4	0.37	1.4	0.37	1.4	0.37	1.4	0.37	1.4	0.37
“	O_2	0.4	0.11	1.2	0.34	1.2	0.34	1.3	0.37	1.3	0.37	1.3	0.37	1.9	0.54
“	H_2	0.3	0.09	1.3	0.37	1.3	0.37	1.4	0.40	1.4	0.40	1.4	0.40	1.7	0.49
“	CO_2	0.1	0.03	1.5	0.40	2.5	0.67	2.9	0.78	2.9	0.78	3.3	0.89	3.9	1.05
“	Air	0.7	0.18	1.6	0.41	1.6	0.41	1.7	0.44	2.1	0.54	2.1	0.54	2.3	0.59

TABLE 1.—LOSS IN WEIGHT IN GRAMS AND PERCENT OF SILVER CLUSTER GRAPEFRUIT STORED AT 37° F. IN ATMOSPHERES OF VARIOUS GASES *(Concluded)*.
(Averages of four fruits)

Treatment		After 16 Wks.		After 18 Wks.		After 20 Wks.		After 22 Wks.		Condition of Fruit After 22 Weeks	
Absorbing Agent	Gas	Loss in gms.	Per-cent Loss	Loss in gms.	Per-cent Loss	Loss in gms.	Per-cent Loss	Loss in gms.	Per-cent Loss	Taste	Texture
H_2SO_4	N_2	36.2	9.93	43.1	11.82	48.2	13.22	54.6	14.98	Very good	Slightly soft
"	O_2	37.1	10.21	44.3	12.20	48.6	13.38	54.7	15.06	Stale taste	Soggy
"	H_2	44.9	11.24	54.0	13.51	58.4	14.61	64.9	16.24	Good	Soft
"	CO_2	32.1	8.51	38.7	10.26	Soggy	......	......	......	Unpalatable	Pulp darkened—very soggy
"	Air	37.7	9.96	44.5	11.76	49.2	13.00	55.1	14.56	Good	Soft
KOH	N_2	1.8	0.45	2.4	0.64	2.5	0.66	3.1	0.82	Very good—natural	Firm
"	O_2	2.1	0.51	Blue Mold	....	......	......	......	......	....	....
"	H_2	2.4	0.59	4.1	1.01	4.1	1.01	4.4	1.14	Slight stored taste	Firm
"	Air	2.9	0.77	3.4	0.91	3.5	0.93	4.6	1.33	Good	Firm
None	N_2	1.4	0.37	1.8	0.47	1.9	0.50	2.5	0.65	Very good—natural	Firm
"	O_2	2.0	0.57	2.7	0.82	2.7	0.82	Soggy	......	....	Very soggy—rotted
"	H_2	1.7	0.49	2.7	0.78	2.7	0.81*	2.7	0.81*	Good	Firm
"	CO_2	4.0	1.07	5.0	1.34	Soggy	......	......	......	....	Very soggy—rotted
"	Air	2.3	0.59	2.6	0.67	2.6	0.67	2.8	0.73	Good	Firm

TABLE 2.—STORAGE PITTING OF SILVER CLUSTER GRAPEFRUIT STORED AT 37° F. IN ATMOSPHERES OF VARIOUS GASES*.

Treatment		After 2	After 4	After 6	After 8	After 10	After 12	After 14	After 16	After 18	After 20	After 22
Absorbing Agent	Gas	Weeks	Weeks	Weeks	Weeks	Weeks	Weeks	Weeks	Weeks	Weeks	Weeks	Weeks
H_2SO_4	N_2	—	—	—	—	+ —	+ —	+ —	+ —	+ —	+ —	+ —
“	O_2	—	+ —	+	+	+ +	+ +	+ +	+ +	+ +	+ +	+ +
“	H_2	—	+ —	+ —	+	+	+	+	+	+	+	+
“	CO_2	—	—	—	+ —	+ —	+ —	+ —	+ —	+ —	+ —	+ —
“	Air	—	+	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+ + +
KOH	N_2	—	—	+	+	+	+	+ +	+ +	+ +	+ +	+ +
“	O_2	—	+ —	+	+	+	+	+	+	+	+	+
“	H_2	—	+ —	+	+	+ +	+ +	+ +	+ +	+ +	+ +	+ +
“	Air	—	+ —	+ —	+ —	+ —	+	+	+	+	+	+
None	N_2	—	—	—	—	—	—	+ —	+ —	+ —	+ —	+ —
“	O_2	—	+ —	+ —	+ —	+ —	+ —	+ —	+ —	+ —	+ —	+ —
“	H_2	—	—	+ —	+ —	+ —	+ —	+ —	+ —	+ —	+ —	+ —
“	CO_2	—	—	+ —	+ —	+ —	+ —	+ —	+ —	+ —	+ —	+ —
“	Air	—	—	+ —	+ —	+ —	+ —	+ —	+ —	+ —	+	+

*Pitting Rating: (—), no pits; (+ —), 1 to 15 pits per fruit; (+), 16 to 30 pits per fruit; (+ +), 31 to 45 pits per fruit; (+ + +), 46 to 60 pits per fruit.

The loss of weight here seems to be affected mostly by the humidity of the atmosphere, the dry atmosphere, produced over H_2SO_4, causing about 20 times as much loss of weight as the humid atmosphere[2] in the desiccator with no absorbent.

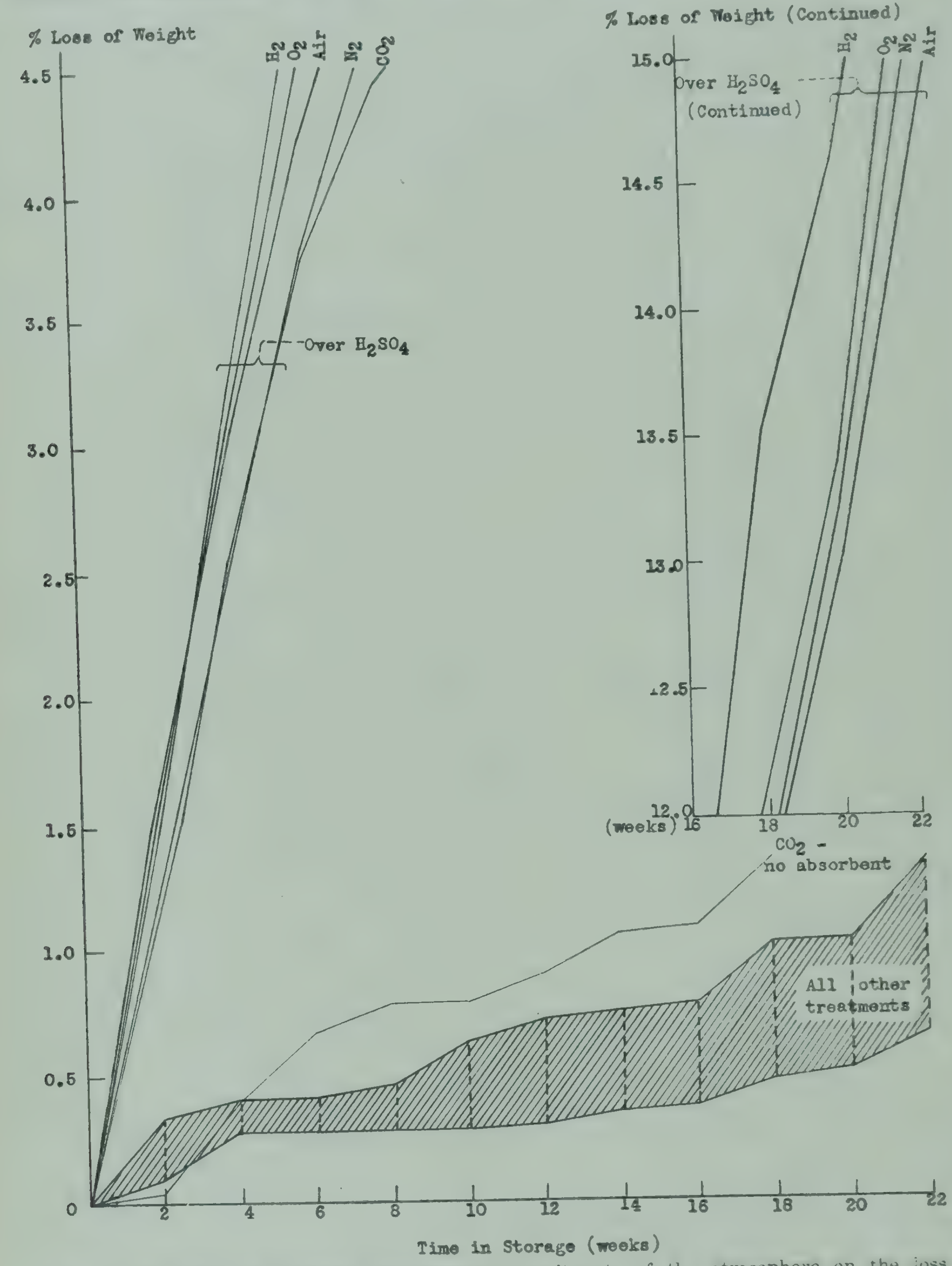

Fig. 2.--The effect of humidity and gaseous constituents of the atmosphere on the loss of weight of Silver Cluster grapefruit in "still air" storage at 37° F.

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[2] Droplets of water were continually present on the walls of these desiccators, indicating a vapor pressure equal to that of saturation at this temperature (37° F.).

The gases seemed to have very little effect on the loss of weight. Of the fruit in the dry atmospheres (over H_2SO_4) those in CO_2 lost less weight, while those in O_2 and H_2 lost the most, the fruit in CO_2 losing about 0.8 as much weight as those in the H_2 or O_2 gases. Most of this difference can be attributed to a retardation of respiratory activity by the CO_2 gas but probably part of it is due to the drying effect of the other gases. It has been found by the authors, in subsequent experiments on respiration of citrus fruit (the results of which will be published when completed) that about 20% of the total loss of weight of citrus fruit in a normal atmosphere is due to respiration.

The high loss of weight of the fruit in CO_2 gas with no absorbent is attributed to the "soggy" condition of the fruit. This condition, to be discussed in more detail later, causes an abnormal increase in transpiration. At the end of 18 weeks, the "soggy" fruit lost nearly twice as much weight as those fruits in other gases and not soggy.

With reference to texture and taste, which are, after all, the most important factors to be considered, it is observed from Table 1 that atmospheres of both pure CO_2 and O_2 show consistent deleterious effects on the taste and texture of the fruit in both extremes of humidity. The fruit in N_2, H_2 and ordinary air had a good taste in both dry and moist atmospheres. These fruit were quite soft, after 22 weeks in the dry atmosphere, due to drying and wrinkling of the rind, but were very firm and had a good bright appearance in both the humid atmospheres. Thus, it is seen here that texture is affected by both humidity and gaseous constituents of the atmosphere and taste seems to be affected only by the kind of gas.

Table 2 shows the relative degree of pitting in the various atmospheres used here. Pitting was most severe in all gases used in the dry atmospheres (over H_2SO_4) and least severe in the humid atmospheres with no absorbing agent. In the presence of small amounts of CO_2 (that respired by the fruit between application of gases)[3] all gases reduced pitting over that in air, N_2 gas reducing it most. In the absence of CO_2 gas (over KOH) pitting was more severe in all the gases, except

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[3] CO_2 was present in all cases except where KOH was used as the absorbing agent. This solution absorbs CO_2 gas rapidly.

O_2, than in air. The indications are that CO_2 aids in reducing pitting, since CO_2 gas is deleterious to texture in high concentrations, N_2 gas here seems to be the most favorable atmosphere if it contains a small amount of CO_2. Ordinary air with low O_2 content would approach this condition.

This experiment was continued to study in more detail the effects of O_2 and CO_2 on the fruit and to confirm the previous results.

Freshly picked Silver Cluster grapefruit were washed and put in desiccators which contained water, $Ba(OH)_2$ (10% solution), concentrated H_2SO_4 and no absorbing agent, respectively. Air, O_2 and CO_2 were used as atmospheres.

Severely pitted grapefruits taken from the cold storage plant were placed in atmospheres of O_2 and CO_2 gases, with H_2SO_4 as an absorbent.

Partially soggy fruits, developed during the preceding experiment, were placed in atmospheres of O_2 gas with water, $Ba(OH)_2$ and H_2SO_4 as absorbents in the bottom of the desiccators. Another desiccator containing O_2 gas but no absorbent served as a check.

The atmospheres were flushed with their respective gases every two days, using the same method as was used above. In addition to the observations made in the previous experiment, each fruit was weighed individually at weekly intervals and the percent loss in weight determined.

These results are shown in Table 3. The data on soggy fruits show no improvement of the soggy condition or retardation of the soggy-deterioration process by treating the fruit with O_2 gas under any condition of humidity used in this experiment. All good fruit treated with CO_2 gas began to get soggy after four or five weeks and continued to break down with blue mold finally attacking the already soggy fruit.

Sogginess generally began at the blossom end of the fruit, and was accompanied by soft, dull-colored areas. These areas gradually increased in size until the entire fruit was affected. The rind seemed to be "water-logged" and the fruit developed a musty odor. As sogginess developed, the entire fruit became soft and spongy, with complete loss of turgor and, in later stages, often had discolored juice dripping from it. Small white to cream-colored crystals of naringen, a glucoside found in grapefruit (hesperidin in the case of oranges), were often seen deposited just beneath the thin outer epidermal layer of cells.

TABLE 3.—PERCENT LOSS IN WEIGHT OF SILVER CLUSTER GRAPEFRUIT STORED AT 37° F. IN VARIOUS ATMOSPHERES.

	Absorbing Agent	Gas	Percent loss in weight after										Condition of fruit after 10 wks.
			1 wk.	2 wks.	3 wks.	4 wks.	5 wks.	6 wks.	7 wks.	8 wks.	9 wks.	10wks.	
Good Fruit	H_2SO_4	O_2	1.70	1.81	1.96	3.29	4.79	6.17	7.52	9.17*	10.94	15.06	Firm—2 B. M.**
Good Fruit	H_2SO_4	CO_2	1.63	2.16	3.47	4.42	5.44	6.89	7.33	8.62	9.64	11.56	Very soggy
Good Fruit	H_2SO_4	Air	1.18	2.14	3.48	4.37	5.55	6.79	7.93	9.54	10.89	13.27	Soft and dry
Good Fruit	$Ba(OH)_2$	O_2	0.11	0.24	0.37	0.48	0.76	0.84*	1.02	1.30	1.35	1.35	Firm—3 B. M.
Good Fruit	$Ba(OH)_2$	Air	0.02	0.07	0.42	0.52	0.77	0.92	0.92	1.32	1.37	1.60	Firm—2 B. M.
Good Fruit	Water	O_2	0.00	0.09	0.25	0.34	0.42	0.61*	0.61	0.85	0.87	1.07	Firm—2 B. M.
Good Fruit	Water	CO_2	0.02	0.14	0.19	0.39	0.41	0.43	0.43	0.43	0.53	0.53	Very soggy
Good Fruit	Water	Air	0.18	0.18	0.51	0.79	0.82	0.82	0.85	1.29	1.29	1.29	Firm—3 B. M.
Good Fruit	None	O_2	0.35	0.35	0.77	1.05	1.26*	1.37	1.37	1.73	1.91	2.40	Firm—3 B. M.
Good Fruit	None	CO_2	0.28	0.54	0.80	1.11	1.28	1.85	1.85	2.19	2.19	2.19	Very soggy
Good Fruit	None	Air	0.00	0.00	0.14	0.17	0.31	0.37	0.37	0.51	0.51	0.67	Firm—1 B. M.
Pitted Fruit	H_2SO_4	O_2	1.63	2.11	3.91	5.56	6.92*	9.20	10.38	12.20	13.97	13.97	All B. M.
Pitted Fruit	H_2SO_4	CO_2	0.51*	1.33	2.01	2.83	3.62	3.93	4.75	6.20	7.11	9.15	Very soggy
Soggy Fruit	H_2SO_4	O_2	1.15	2.14	3.36	4.49	......	......	......	......	......	......	Very soggy—B. M.
Soggy Fruit	$Ba(OH)_2$	O_2	0.09	1.14	......	......	......	......	......	......	......	......	Very soggy—B. M.
Soggy Fruit	Water	O_2	0.05	0.65	......	......	......	......	......	......	......	......	Very soggy—B. M.
Soggy Fruit	None	O_2	0.19	4.27	......	......	......	......	......	......	......	......	Very soggy—B. M.

*Average of 3 fruits—all others are averages of 4 fruits.

**Indicates 2 fruits decayed with Blue Mold.

This condition appeared to be a result of CO_2 toxicity which caused a cessation of respiration activity and the subsequent death of the fruit. The exact physiological changes taking place when this condition develops are being studied but, at the present time, the direct cause is unknown. It was induced by high concentrations of CO_2 gas in all cases and often, as was noted in later experiments, caused serious loss of fruit in storage. It is thought to be a suffocation or drowning of the fruit by the CO_2 gas which cuts off respiration almost entirely.

When anaerobic respiration takes place, toxic by-products are often formed which are fatal to the living protoplasm. Then, due to the increased permeability of the tissue caused by the CO_2 gas, various solutes and gases diffuse throughout the tissue of the fruit, until the juice, as well as the oil from the rind, is soaked up into the albedo (the white part of the rind), causing a sodden or "soggy" condition. The air passages are essentially clogged up, preventing the normal gaseous exchange with the outer atmosphere.

It was also noted, in studying the soggy fruit, that certain oxidizing enzymes, such as catylase and oxygenase, entirely disappear in the soggy fruit while oxidase seems to be diffused throughout the fruit tissues. In fruits that are not soggy, these enzymes are present in abundance and oxidase appears only in the vascular system, or veins. Whether this is primary or secondary in the development of sogginess awaits the results of further experimentation.

The deleterious effect of O_2 gas is thought to be due to excess oxidation (increasing respiratory activity) and growth of organisms causing decay. Blue mold, in particular, was noticed to grow abundantly in an O_2 atmosphere.

As far as loss of weight is concerned, these results further confirm the results previously found, i. e., the variation in the loss of weight is largely caused by the humidity of the atmosphere.

The results of these preliminary experiments indicate: Loss of weight, firmness, and, to a certain extent, pitting, are affected greatly by the humidity of the atmosphere. Taste and texture are greatly affected by the gaseous constituents of the atmosphere, O_2 and CO_2 proving very deleterious to both texture and taste. Oxygen and H_2 tend to increase pitting and N_2 to decrease it over ordinary air.

Sogginess, or physiological breakdown, developed profusely in an atmosphere of CO_2 while the deleterious effect of O_2 was mostly from organisms causing decay (primarily blue mold). The fruits not infected by these organisms were in good condition.

EXPERIMENTS WITH NITROGEN GAS

After these preliminary experiments, it was decided to devise a means of working with a larger number of fruits under controlled atmospheric conditions so that the error of individual variation in the fruit could be eliminated. For this purpose, large metal cans were used as shown in Fig. 3. Six-inch nipples of 3/8-inch iron pipe were soldered into each can at top and bottom as shown (A and B). A circular basin (D) was made from galvanized sheet iron with an elevated center upon which a wire cage made of 4-mesh galvanized wire rested. This cage held the fruit under experiment. The circular trough was filled about two inches deep with regular lubricating oil[4]. When sealing the container, the metal can was inverted over the cage of fruit and lowered into the oil, thus making an oil seal around the rim of the can. Short pieces of rubber tubing with screw clamps were provided for

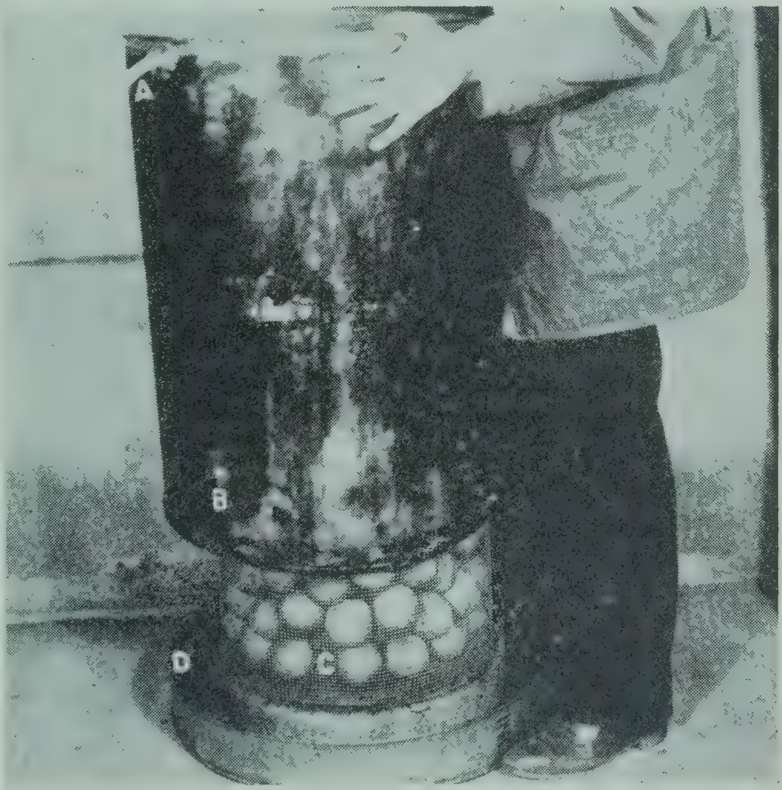

Fig. 3.—Showing method of keeping fruit in air-tight container.

A and B—3/8-inch metal tubes sealed into metal cover through which various gases were supplied, and samples of the atmosphere over the fruit were taken for analysis.

C—Wire cage of 4-mesh galvanized wire in which the fruit was placed.

D—Circular basin holding ordinary lubricating oil. The rim of the metal cover was lowered into this oil trough, making an air-tight seal.

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[4] This oil was used because it was non-volatile and produced no vapors that were deleterious to the fruit.

the inlet and outlet tubes (A and B) through which the atmospheres were replenished. When the fruit was inspected, the inverted can was partly raised as shown (Fig. 3) and the oil cleaned from its rim so that none of the oil dripped on the fruit when it was completely removed.

In this first experiment with these containers only N_2 gas was used as an artificial atmosphere. This was checked against ordinary air. Both Pineapple oranges and McCarty grapefruit were used.

Thirty fruits from each container were weighed individually at each inspection and the average percent loss of weight was calculated. Also, 100 extra oranges and 50 extra grapefruit were placed in the respective containers for other observations such as texture, taste, pitting and general condition. Four containers were set up, as follows:

Container A—Pineapple oranges treated with N_2 gas
Container B—Pineapple oranges treated with ordinary air
Container C—McCarty grapefruit treated with N_2 gas
Container D—McCarty grapefruit treated with ordinary air

Inspections were made every two weeks and samples of the atmospheres were drawn and analyzed for volume percent of CO_2 and O_2 before and after each inspection. The analyses of the atmospheres after each inspection of the fruit were made the following day after the containers were closed and the gas treatments made. These analyses were made with a portable Haldane air analysis apparatus (*8*) using 10% KOH for absorbing CO_2 and concentrated KOH containing 10% pyrogallic acid for absorbing O_2. The apparatus described by Haldane (*8*, p. 48) was used without the combustion chamber. An accuracy of 0.02% was easily obtained when used in the constant temperature storage room. In supplying the N_2 gas to these containers, the bottom nipple (B in Fig. 3) was connected to the compressed N_2 gas cylinder and the gas was allowed to flow for 15 minutes under 5 pounds pressure. This was found to be enough to flush the container thoroughly with the gas.

Results of this experiment are shown in Table 4. As both of the atmospheres used were humid, the loss of weight was very low with no appreciable difference between N_2 gas and ordinary air.

Pitting was negligible in all containers.

The taste seemed to be affected mostly in the N_2 gas atmosphere. The "off taste" here recorded was a disagreeable pun-

TABLE 4.—EFFECT OF NITROGEN ATMOSPHERE IN AIR-TIGHT STORAGE AT 37° F. ON THE KEEPING QUALITY OF PINEAPPLE ORANGES AND McCARTY GRAPEFRUIT.

Container	Time of Inspection	Composition of Atmosphere						% Loss of Wgt.	Condition	
		After Closing			Before Opening					
		% CO_2	% O_2	% Inert*	% CO_2	% O_2	% Inert		Firmness	Taste
“A” Nitrogen Gas (Pineapple oranges)	Initial	2.50	2.16	95.34	....	....	....	......	Firm and good	Good
	After 2 weeks	....	....	....	....	....	....	0.55	Firm and good	Good
	“ 4 “	4.93	0.20	94.87	23.68	0.01	76.31	0.89	Firm and good	Musty
	“ 6 “	4.14	0.06	95.80	25.04	0.11	74.85	1.24	Firm and good	Musty
	“ 8 “	2.28	0.63	97.12	21.53	0.04	78.43	1.54	Fairly firm	Bad off-taste
	“ 10 “	4.69	3.98	91.33	18.18	0.07	81.75	1.68	Slightly soft	Bad off-taste
	“ 12 “	1.53	2.18	96.29	14.58	0.11	85.32	1.87	Slightly soft	Bad off-taste
	“ 14 “	3.47	2.41	94.12	6.33	0.12	93.55	1.98	Soggy and soft	Musty—Carbonated
	“ 16 “	0.38	11.26	88.36	2.77	0.59	96.64	2.46	Appear good—Soggy rind	Bad-Musty
	“ 18 “	All fruits have good color, soggy-soft, and 2% Molds**								
“B” Ordinary Air (Pineapple oranges)	Initial	....	....	....	....	....	....	......	Firm and good	Good
	After 2 weeks	....	....	....	....	....	....	0.42	Firm and good	Good
	“ 4 “	8.49	14.98	76.53	29.68	0.37	69.95	0.67	Fairly firm	Fair
	“ 6 “	7.18	13.30	79.52	29.60	0.48	69.92	0.80	Fairly firm	Slight off-taste
	“ 8 “	8.15	16.47	75.38	29.73	Trace	70.26	0.94	Fairly firm	Slight off-taste
	“ 10 “	10.70	14.91	74.31	27.78	0.06	72.16	1.02	Slightly soft	Slight off-taste
	“ 12 “	8.49	16.37	75.16	28.06	0.25	71.69	1.11	Slightly soft	Slight off-taste
	“ 14 “	16.88	9.87	73.25	22.88	4.05	73.07	1.33	Soggy—soft	Off-taste
	“ 16 “	0.85	11.86	88.29	13.25	0.53	86.22	1.27	Soggy—soft	Off-taste
	“ 18 “	Good color, soggy-soft, skin pliable, 10% Molds—General good appearance								

*Mostly Nitrogen.

**The fruits were left out of the containers at the end of 16 weeks.

TABLE 4.—EFFECT OF NITROGEN ATMOSPHERE IN AIR-TIGHT STORAGE AT 37° F. ON THE KEEPING QUALITY OF PINEAPPLE ORANGES AND McCARTY GRAPEFRUIT *(Concluded)*.

Container	Time of Inspection	Composition of Atmosphere						% Loss of Wgt.	Condition	
		After Closing			Before Opening					
		% CO_2	% O_2	% Inert*	% CO_2	% O_2	% Inert		Firmness	Taste
“C” Nitrogen Gas (McCarty grapefruit)	Initial	3.37	4.82	91.81	....	....	....	.....	Firm and good	Good
	After 2 weeks	3.37	4.82	91.81	7.23	0.24	92.53	0.41	Firm and good	Good
	“ 4 “	4.13	0.04	95.83	11.62	0.02	88.36	0.52	Firm and good	Good
	“ 6 “	1.48	1.68	96.84	14.10	1.07	84.83	0.60	Firm and good	Slightly musty
	“ 8 “	0.70	0.58	98.72	14.67	0.28	85.05	0.71	Firm and good	Slightly musty
	“ 10 “	1.42	2.77	95.71	13.76	0.72	85.52	0.83	Firm and good	Slightly musty
	“ 12 “	4.58	9.57	85.85	13.49	6.88	79.63	0.95	Firm and good	Fair
	“ 14 “	6.75	0.60	92.65	12.92	0.40	86.68	1.10	Fairly firm	Fair
	“ 16 “	....	....	....	14.10	0.61	85.29	1.34	Slightly soft	Slight off-taste
“D” Ordinary Air (McCarty grapefruit)	Initial	....	....	....	....	....	....	.....	Firm and good	Good
	After 2 weeks	....	....	....	7.74	10.01	82.25	0.38	Firm and good	Good
	“ 4 “	5.99	16.02	77.99	12.26	7.72	80.02	0.44	Firm and good	Good
	“ 6 “	4.66	17.81	77.53	22.73	0.85	76.42	0.54	Firm and good	Good
	“ 8 “	6.08	18.49	75.43	22.74	3.03	74.23	0.68	Firm and good	Fair
	“ 10 “	10.07	15.96	73.97	27.16	0.20	72.64	0.77	Firm and good	Fair
	“ 12 “	13.19	13.34	73.47	29.25	0.12	70.63	1.00	Fairly firm	Fair
	“ 14 “	14.94	12.22	72.84	22.24	4.45	73.31	1.10	Fairly firm	Fair
	“ 16 “	....	....	....	18.18	0.36	81.46	1.34	Slightly soft	Fair

*Mostly Nitrogen.

gent taste with a slightly bitter after-taste. The N_2 gas seems to speed up the development of the "off taste", which is accompanied by a "musty" flavor.

It is seen from the analysis of the atmosphere that the fruit in both containers respired enough to raise the CO_2 content considerably during the two-weeks intervals between inspections, the main difference in the atmospheres being, roughly, 10% less O_2, and 10% more N_2 in the N_2 gas containers than in ordinary air. The N_2 gas treatment reduced the O_2 content to about 1 or 2 percent and respiration following reduced it still more, with a production of considerable CO_2. Due to frequent ventilation (at the time of inspection) reducing the CO_2 content, the "soggy" condition developed here only after about 3½ months, while in higher concentrations this condition formerly developed within two to three weeks.

The main results obtained were that N_2 gas treatment maintains firmness longer but produces an undesirable taste in both oranges and grapefruit.

The studies with N_2 gas were continued in the air-tight metal containers (Fig. 3). Lowering the O_2 content by displacement with N_2 gas, varying the CO_2 content (that respired by the fruit and accumulating in the containers) by absorbing it with NaOH solution and varying the humidity by the use of H_2SO_4 as a moisture absorbent, six containers were set up with Duncan grapefruit as shown in Table 5. The absorbing solutions were placed in shallow porcelain dishes beneath the fruit in the wire cages, the fruit being supported by a wooden stool set over the dishes. The fruit was picked from the Experiment Station grove (the freshly cut stems being treated immediately with 95% alcohol to eliminate stem-end rot infection, as far as possible), washed, graded and sized. Seven lots of 91 fruits each were prepared with approximately the same sizes of fruit in each lot. One lot was placed in each of six containers to be closed air-tight and one lot was placed in a wire cage similar to the ones used in the air-tight containers but left open for a check. In each lot 25 fruits were weighed individually every two weeks. The remainder were used for observations of taste, texture, firmness, etc.

In Table 5 only the results at the end of each month are given for the first three months, since there was very little change taking place during this time. All figures are calculated on a basis of the original number of fruit used. The decayed fruits were discarded at each inspection. All of the figures are total percentages at any one time during the storage period. The figures on the composition of the atmosphere are averages of all analyses up to the indicated time in storage. The analyses were made with the Haldane air analysis apparatus mentioned previously (*8*).

In this experiment another factor affecting loss of weight, that of air circulation, is involved. Although the relative humidity in the storage room was fairly high (averaging about 85%) fruits in the room lost four times as much weight as those in the closed containers. Differences in loss of weight of fruit in the different air-tight containers were negligible. The drying effect of the H_2SO_4 in the container was not very efficient, because the quantity of H_2SO_4 was so small in proportion to the volume of air space within the container. The acid soon became so dilute that its dehydrating power was ineffectual. This high loss of weight in a relatively humid storage room would seem to contradict the conclusion previously drawn, but it merely emphasizes another important factor, as will be proven later, that is, the effect of air circulation. The cold storage rooms are so constructed that forced air circulation is necessary

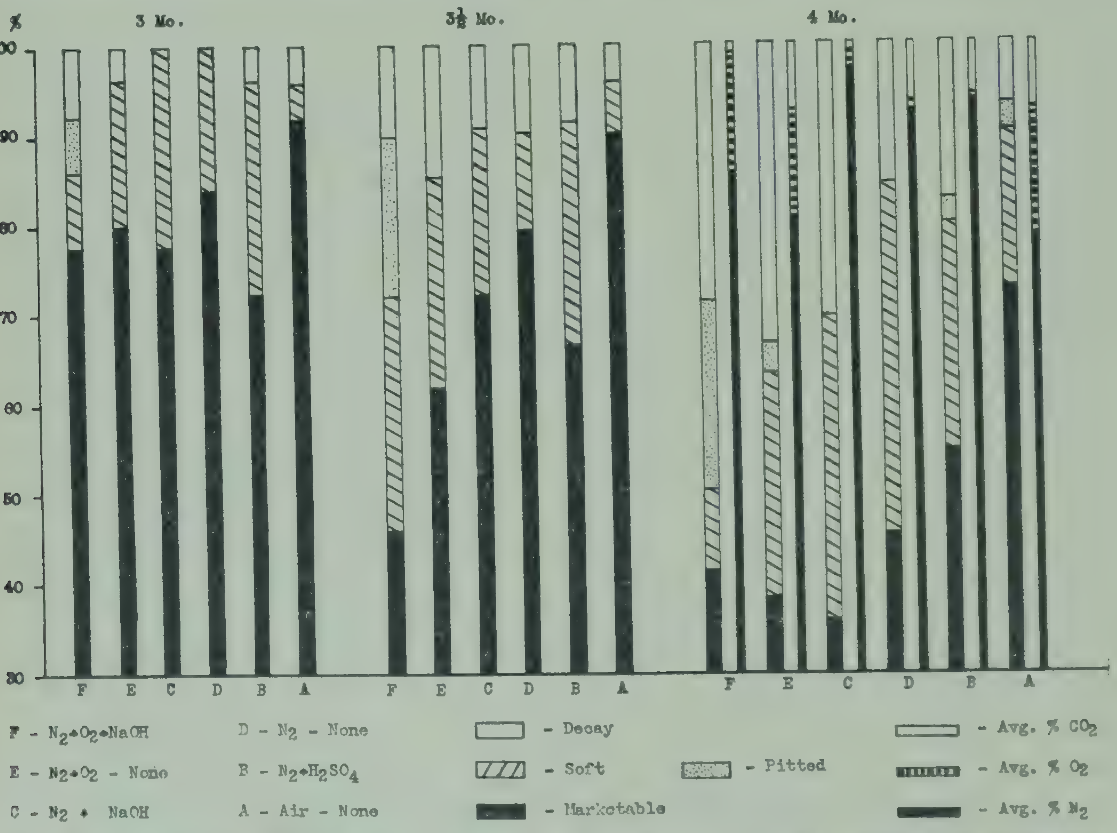

Fig. 4. The relative keeping quality of Duncan grapefruit in various atmospheric conditions stored in air-tight containers at 37° F.

TABLE 5.—EFFECT OF VARIOUS ATMOSPHERES WITH NITROGEN GAS ON THE KEEPING QUALITY OF DUNCAN GRAPEFRUIT STORED IN AIR-TIGHT CONTAINERS AT 37° F.

Container	Treatment		Time in Storage	Condition of Fruit During Storage						Average Composition of Atmosphere			Taste
				Percent Unmarketable Due to				Percent Marketable	Percent loss in Weight				
	Absorbent used	Gas used	mos.	Pitted	Decay	Softened	Total			% CO_2	% O_2	% N_2	
A	None	Air	1	......	......	......	......	100.0	0.8	5.5	16.4	78.1	Good
An ordinary air-			2	......	......	......	......	100.0	1.7	7.6	14.1	78.3	Good
tight atmosphere			3	......	4.0	4.0	8.0	92.0	3.0	6.8	14.6	78.6	Good
—very humid			3½	......	4.0	6.0	10.0	90.0	3.2	8.4	13.1	78.5	Slight storage taste
			4	2.9	6.9	17.6	27.4	72.6	3.7	7.3	14.2	78.5	Slight storage taste
B	H_2SO_4	N_2	1	......	......	......	......	100.0	1.2	6.1	1.1	92.8	Good
			2	......	......	......	......	100.0	2.6	6.0	0.6	93.4	Good
Dry atmosphere			3	......	3.6	24.0	27.6	72.4	4.2	7.3	0.8	91.9	Slight off-taste
—low in oxygen			3½	......	8.6	25.0	33.6	66.4	4.6	5.4	1.0	93.6	Off-taste
			4	2.8	17.1	25.7	45.6	54.4	5.3	5.7	0.5	93.8	Bad off-taste
C	NaOH	N_2	1	......	......	......	......	100.0	1.3	1.1	1.1	97.8	Good
Medium - humid			2	......	......	......	......	100.0	2.5	0.8	1.5	97.7	Slight storage taste
atmosphere—low			3	......	......	22.4	22.4	77.6	4.5	0.4	1.3	98.3	Flat off-taste
in CO_2 and O_2			3½	......	9.3	18.6	27.9	72.1	4.8	0.7	2.0	97.3	Flat off-taste
			4	......	30.5	33.3	63.8	36.2	5.4	1.0	1.8	97.2	Bad off-taste

TABLE 5.—EFFECT OF VARIOUS ATMOSPHERES WITH NITROGEN GAS ON THE KEEPING QUALITY OF DUNCAN GRAPEFRUIT STORED IN AIR-TIGHT CONTAINERS AT 37° F. *(Concluded).*

Container	Treatment		Time in Storage	Condition of Fruit During Storage						Average Composition of Atmosphere			Taste
				Percent Unmarketable Due to				Percent Marketable	Percent loss in Weight				
	Absorbent used	Gas used	mos.	Pitted	Decay	Softened	Total			% CO_2	% O_2	% N_2	
D Humid atmosphere—low in O_2	None	N_2	1	......	......	......	......	100.0	1.1	6.0	1.0	93.0	Good
			2	......	......	......	......	100.0	2.5	5.4	0.7	93.9	Good
			3	......	......	16.3	16.3	83.7	3.8	7.1	0.8	92.1	Off-taste
			3½	......	9.3	11.6	20.9	79.1	4.1	6.4	0.7	92.9	Off-taste
			4	......	15.3	39.3	54.6	45.4	4.9	6.6	1.0	92.4	Off-taste
E Humid atmosphere, medium O_2 content	None	N_2 + 12% O_2	1	......	......	......	......	100.0	1.3	8.4	12.8	98.8	Good
			2	......	......	......	......	100.0	2.6	7.8	11.7	80.5	Good
			3	......	3.6	16.3	19.9	80.1	3.9	9.2	12.6	78.2	Good
			3½	......	14.7	23.2	37.9	62.1	4.2	6.3	12.0	81.7	Fair
			4	3.1	33.4	25.0	61.5	38.5	5.0	7.5	11.5	81.0	Slight off-taste
F Medium - humid atmosphere, low in CO_2 and medium O_2 content	NaOH	N_2 + 12% O_2	1	......	......	......	......	100.0	0.8	1.0	12.4	86.6	Good
			2	......	......	......	......	100.0	2.4	0.9	11.8	87.3	Slight off-taste
			3	6.2	8.0	8.3	22.5	77.5	3.9	0.7	11.7	87.6	Slight off-taste
			3½	17.9	10.5	25.6	54.0	46.0	4.3	1.3	12.6	86.1	Slight off-taste
			4	21.2	28.6	9.0	58.8	41.2	5.2	1.0	12.8	86.2	Off-taste
Check Open storage atmosphere similar to outside air in O_2, CO_2 and N_2	None	None	1	......	......	12.5	12.5	87.5	4.4	0.3	20.3	79.4	Good
			2	Shriveling, pitting and softening				None	11.2	0.4	20.5	79.1	Storage taste
			3	Badly shriveled and dry				None	15.7	0.2	20.6	79.2	Bad storage taste
			3½	Badly shriveled and dry				None	17.8	0.3	20.6	79.1	Unpalatable
			4	Dry and turning brown				None	20.2	0.5	21.0	78.5	Unpalatable

for maintaining constant temperature[5]. These air currents continually blowing over the fruit in the uncovered wire cage caused considerable loss of weight. Further experiments on "still air" storage are reported below.

A graphical representation of the data shown in Table 5 is given in Fig. 4, with the exception of the check lot, which is shown in the table to have no marketable fruit at the end of two months.

In these containers no sogginess developed. This is attributed to the fact that the CO_2 content was seldom over 6 or 7 percent. Pitting was also greatly reduced in all containers over that of the check lot. The variations in the degree of pitting showed a slight parallel to the percentage of O_2, as was shown above, with the exception of Container B (over H_2SO_4). Containers A, E and F, having the highest percent of O_2, showed the most pitted fruit.

The taste seemed to remain about the same in all containers, but quickly became undesirable in the check container which was in open air.

The container (C) having the highest average percent N_2 had the least amount of marketable fruit at the end of four months.

In general, these experiments indicate that ordinary air fairly low in CO_2 and O_2 keeps fruit in the best condition if it is in a closed container where the humidity is high. Fruits that remained in the best condition for four months were those stored in "still air" and ventilated every two weeks (at time of inspection). This atmosphere averaged 7.3% CO_2, 14.2% O_2 and 78.5% N_2 for the four months, with 72.6% of the fruit marketable at the end of this time. The storage life of citrus fruit can be greatly lengthened by "still air" storage with proper ventilation to prevent the accumulation of respired CO_2 and to prevent air currents from fanning the surface of the fruit.

It is also noted that low concentrations of CO_2 are desirable, about 5 to 6 percent giving better results than higher concentrations or no CO_2 at all. It is also desirable to have a low O_2 content to cut down respiration and to inhibit growth of strongly aerobic organisms. These results are further confirmed in the following experiments with "still air" storage and controlled ventilation.

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[5] The reader is referred to a complete description of the cold storage plant given in the introduction to Reference 15.

CONTROLLED VENTILATION

Valencia oranges were obtained from the Citrus Experiment Station at Lake Alfred, Florida, and placed in the metal containers as follows: Four containers were used, each having 56 oranges wrapped in tissue paper (regular packinghouse wrapper) and 56 oranges without wrappers. The individual weights of 16 fruits in each container (eight wrapped and eight not wrapped) were recorded at the beginning of the experiment and at four-weeks intervals thereafter. The fruit was ventilated by removing the metal cover, thus exposing the fruit to the open atmosphere for a few minutes, according to the following schedule:

Container A—Cover removed every two days
Container B—Cover removed every seven days
Container C—Cover removed every 14 days
Check (open air)—no cover

Analyses of the air were made every two weeks to determine the concentration of CO_2 and O_2, and the fruit was inspected for general condition and loss of weight every four weeks.

In Table 6 data from these inspections are tabulated for 8, 12 and 16 weeks, respectively. No appreciable difference between tissue wrapped fruit and those not wrapped was found. All fruit in closed containers was much better than the check lot in ordinary storage (continuously ventilated), the check lot having about 10% unmarketable and 40% slightly damaged by drying and softening but still marketable after eight weeks in storage, while those in "still air" had no unmarketable fruit and only about 10% slightly damaged by this time. At the end of 12 weeks, all fruits were damaged in the check lot and about 20% were unmarketable. The most frequently ventilated container, A, had only 12% slightly damaged and the less frequently ventilated containers, B and C, had about 35% slightly damaged at this time. These results are shown graphically in Fig. 5.

In general, the results show that "still air" storage with ventilation at intervals is far superior to open-air storage (continuous ventilation) in preserving the good condition of the fruit. Frequent ventilation to prevent the accumulation of respiratory gases is a great aid in preserving the fresh condition.

Loss of weight of the fruit was greatly reduced by still-air storage, compared to that in the ordinary storage room. This

TABLE 6.—EFFECT OF VENTILATION ON THE KEEPING QUALITY OF VALENCIA ORANGES IN AIR-TIGHT STORAGE AT 37° F.

Treatment	Wrapper	After 8 weeks					After 12 weeks					After 16 weeks				
		% Damaged but Marketable	% Not Marketable (soft, soggy, etc.)	% Decay	% Marketable	%Loss of Weight	% Damaged but Marketable	% Not Marketable (soft, soggy, etc.)	% Decay	% Marketable	%Loss of Weight	% Damaged but Marketable	% Not Marketable (soft, soggy, etc.)	% Decay	% Marketable	%Loss of Weight
Check—Open air	Tissue	39.3	10.7	......	89.3	11.3	80.3	18.8	0.9	80.3	12.8	0.0	100.0	......	None	......
	None	41.1	7.1	......	92.9	11.3	80.3	18.8	0.9	80.3	13.0	0.0	100.0	......	None	......
Opened every two days	Tissue	5.4	......	......	100.0	1.7	10.7	......	1.8	98.2	2.2	8.9	1.8	8.9	89.3	3.0
	None	8.9	......	......	100.0	1.3	12.5	......	3.6	96.4	1.5	17.9	1.8	5.4	92.8	4.5
Opened every seven days	Tissue	12.5	......	......	100.0	2.1	35.7	......	......	100.0	2.9	28.6	3.6	3.6	92.8	4.5
	None	7.1	......	......	100.0	2.0	39.3	......	......	100.0	3.0	28.6	8.9	1.8	89.3	4.4
Opened every 14 days	Tissue	10.7	......	......	100.0	1.7	28.6	......	......	100.0	2.4	32.1	12.5	......	87.5	3.2
	None	5.4	......	......	100.0	1.4	32.1	......	......	100.0	2.2	35.7	12.5	......	87.5	2.9

method of storage requires new design in refrigeration rooms (Fig. 6) if it is to be used on a commercial scale.

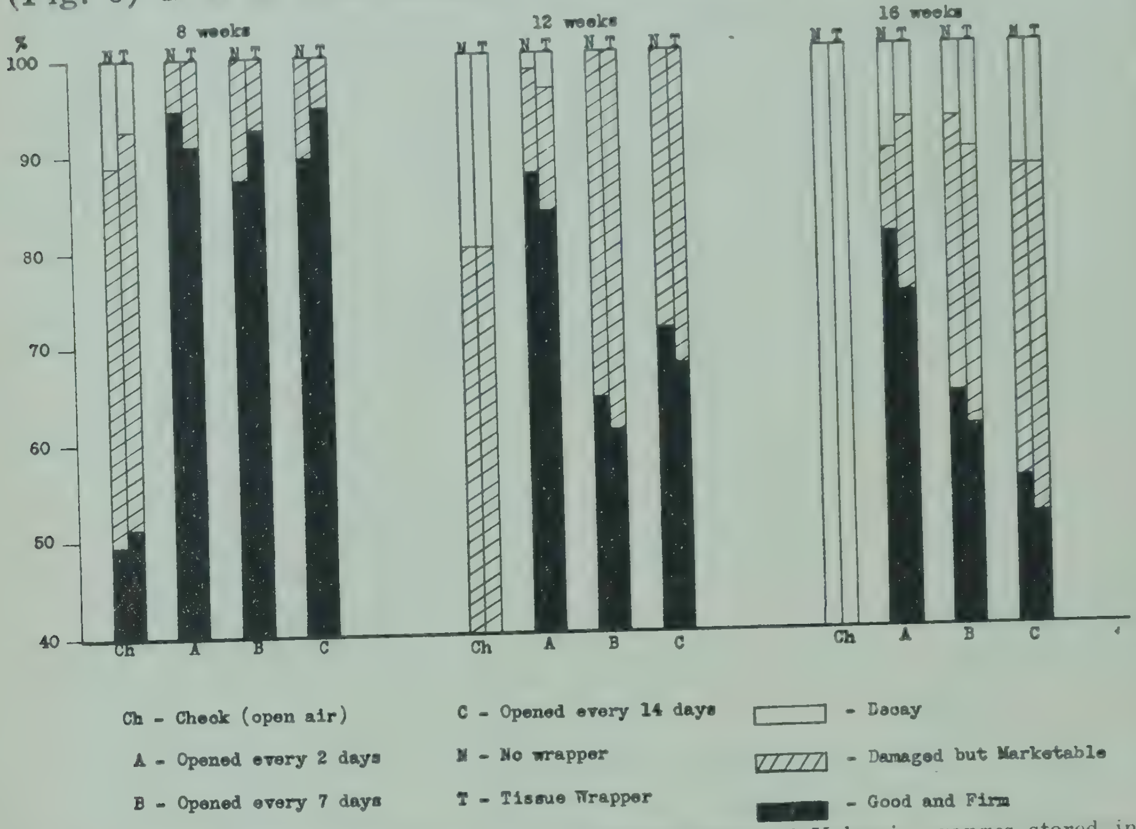

Fig. 5.—Relative effect of ventilation on the keeping quality of Valencia oranges stored in air-tight containers at 37° F.

Commercial Application[6].—For the purpose of trying air-tight storage on a larger scale and providing a means of controlling the atmosphere in a storage room, a sheetiron room was constructed inside one of the regular storage rooms, leaving about two feet of space between the walls and ceiling of the regular storage room and those of the air-tight metal room. The structure of this metal room or "tank", as it has been designated during the experimental work with it, is shown diagrammatically in Fig. 6. It is equipped with electric lights and three sealed-in (½-inch) metal tubes running up along the center vent (one shown in diagram), terminating at floor, center and top levels of the "tank" respectively. This provides a means of taking samples of the atmosphere at different levels for analysis or introducing gases into the atmosphere within the "tank". The center vent (H) through which air is constantly circulated provides a more uniform temperature throughout the "tank". Other details of structure are given with the diagram.

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[6] The authors wish to acknowledge the helpful suggestions and aid of W. R. Lyle, graduate assistant in the Department of Horticulture, in this work.

The air-tight metal room essentially produces a condition of indirect refrigeration in that the air of the storage room is cooled by brine and the cooled air in turn cools the interior of the sealed room or tank by conduction of heat through walls of the tank. The effect is to eliminate the freezing out of moisture on the pipes and the consequent de-humidification of the air in the fruit storage room. It is this de-humidification which makes the humidity so difficult to control in storage rooms and upsets the entire balance of moisture relation between fruit and the atmosphere. The tank having a cooling surface over its entire area cools fairly well so that only a small difference in temperature exists between the interior of the tank and the atmosphere of the surrounding room. Consequently the walls of the tank are never at a low enough temperature to cause extreme loss of moisture from the air within the tank. This accomplishes a purpose that is impossible to accomplish with the ordinary refrigeration system where condensation of moisture on the pipes is heavy and fresh moisture must be continually added to the air to compensate for it. The fact that

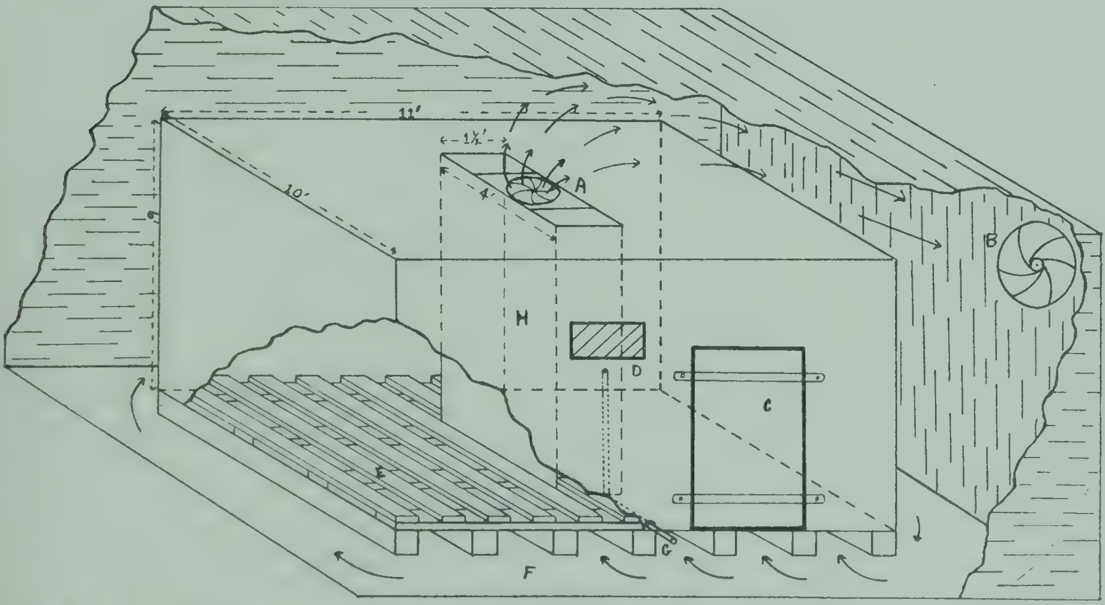

Fig. 6.—Diagram showing air-tight "tank" room built inside regular storage room. The "tank" is made of sheetiron, all seams being soldered air-tight. The door is fitted into an angle-iron frame lined with 3/8-in. soft rubber gasket and bolted in place as shown. Arrows indicate air movement.

A—Fan for circulating cold air through the rectangular opening (H) extending through tank. This device provides more wall surface exposed to cold air, hence a more uniform temperature within the tank.

B—Fan to keep outer room air circulating over cold brine coils located in back of wall.

C—Door to tank bolted in place.

D—Glass observation window sealed into metal wall of tank.

E—Slatted floor of tank to protect sheetmetal floor.

F—Concrete floor of outer room upon which the beams supporting tank rest. Note air space beneath tank.

G—Tube for sampling the atmosphere within the tank.

TABLE 7-A.—EFFECT OF CONTROLLED VENTILATION ON THE MARKETABILITY OF MARSH SEEDLESS GRAPEFRUIT AND VALENCIA ORANGES AFTER 10 WEEKS' STORAGE AT 37° F.

Fruit	Treatment	Wrapper	% Unmarketable		Condition of Fruit	
			Forced Air Circulation	Still Air	Forced Air Circulation	Still Air
Marsh Seedless Grapefruit	Turpentine	None	3.9	1.1	Slightly soft	Firm and good
	Colloidal paraffin	None	6.8	2.5	Soft—fairly good	Firm and good
	Brytex	None	2.8	4.5	Soft—fair	Slightly soft—good
	Cedar oil	None	7.1	10.7	Severely scalded	Scald spots—soft
	None	None	17.1	5.6	Badly shriveled	
	None	Tissue	13.8	10.2	Badly shriveled	Slightly soft—good
Valencia Oranges	None	Tissue	3.0	0.0	Badly shriveled	Slightly soft but good
	None	None	3.8	0.1	Badly shriveled	Slightly soft but good

TABLE 7-B.—COMPOSITION OF ATMOSPHERE IN TANK DURING 10 WEEKS' STORAGE PERIOD (ABOVE).

Time in Storage	Top		Bottom		Average		Remarks
	% CO_2	% O_2	% CO_2	% O_2	% CO_2	% O_2	
After 2 weeks	7.0	11.9	7.2	11.9	7.1	11.9	Ventilated—95% Relative Humidity
After 3 weeks	9.3	11.7	9.7	11.4	9.5	11.6	Ventilated—96% Relative Humidity
After 4 weeks	9.2	12.1	9.1	12.0	9.1	12.1	Ventilated—95% Relative Humidity
After 5 weeks	8.9	12.5	7.7	12.7	8.3	12.6	Ventilated
After 6 weeks	10.9	10.2	11.4	10.5	11.0	10.4	Ventilated
After 7 weeks	10.8	11.2	10.7	10.9	10.8	11.1	Ventilated—Some fruit removed
After 8 weeks	8.1	13.9	4.8	16.3	6.5	15.1	
After 10 weeks	No final analysis made						Remaining fruit removed

Average Weekly Concentration 8.9 12.1 (before ventilation)
Average Weekly Concentration 1.3 20.1* (after ventilation)

*Analyses were not made regularly after ventilation. These figures are averaged from several analyses made irregularly immediately after ventilation.

all of the surfaces of the tank are metal and are open to the air in the room makes it possible to prevent severe stratification of temperature within the tank itself. The transfer of heat from the tank to the surrounding air is enhanced by means of a stack and ventilating fan placed in its center. The constant passage of air through this stack by means of a vent fan increases the cooling capacity of the tank and at the same time insures passage of cool air under the floor of the tank where otherwise the air would likely become pocketed and the refrigeration would be materially decreased.

Sixty-five boxes of fruit (20 boxes of Valencia oranges and 45 boxes of Marsh Seedless grapefruit) were stored as shown in Table 7-A. The treatments indicated were surface treatments applied by hand immediately before storing. The turpentine and cedar oil used were the kinds found in the ordinary laboratory stockroom. The colloidal paraffin was a commercial emulsion of paraffin wax and the Brytex was a commercial emulsion of carnauba wax (80%) and paraffin wax (20%). The tissue wrappers were plain ones commercially used in wrapping fruit. All fruits not treated—both tissue-wrapped and not wrapped—were packed at a packinghouse by commercial packers. The treated fruits were also packed in the same manner but were unpacked for the surface treatment and repacked immediately before storage.

Since these experiments were primarily concerned with the physiological condition of the fruit, fruit lost by decay was discarded and the figures calculated from the number of fruit not attacked by organisms. When a fruit is attacked by blue mold, stem-end rot or other organisms causing decay, it is impossible to observe effects other than those caused by the organism itself.

Table 7-A shows the percentage of fruit that became unmarketable because of softness, sogginess, pitting or shriveling during 10 weeks' storage in the "tank" at 37° F., compared with those stored at the same temperature for 10 weeks in a regular storage room refrigerated by forced air circulation. In all cases, two or more boxes of fruit were used in these comparisons. The average composition of the atmosphere (Table 7-B) in the tank at the end of each week for the 10 weeks' period was 8.9% CO_2 and 12.1% O_2 before ventilation, and the humidity averaged 95% relative humidity. Corresponding figures for the atmosphere of the regular storage room were 0.3%

CO_2, 20.8% O_2 and 87% relative humidity. These differences in the atmosphere were produced by having controlled ventilation. The "tank" was ventilated for a few minutes with an electric fan once a week, the amount of ventilation being adjusted according to the CO_2 content to prevent high concentration of accumulated respiratory gases. The average concentration of CO_2 and O_2 after ventilation was 1.3% and 20.1% respectively. The CO_2 gradually increased and the O_2 gradually decreased, due to the respiratory activity of the fruit, until the next time of ventilation.

Cedar oil is the only surface treatment used that was harmful to the fruit in "still air" storage. These fruits had large discolored or scalded areas on the rinds possibly caused by the dissolution of the cuticle (wax-like coating of the fruit) by the oil.

In the tank the greatest decrease in unmarketability, due to physiological causes, occurred with untreated unwrapped grapefruit. This fruit showed 11.5% more unmarketable fruit after 10 weeks' storage in the continuously ventilated storage room than in the "tank", which was "still air" storage and ventilated at weekly intervals.

All fruit maintained a much better physical condition when stored in the "tank" than when stored in the continuously ventilated storage room. The fruit in the "tank" held a brighter color, maintained good turgor and was generally free from pitting and other skin blemishes caused by storage, while that in the regular storage room acquired a duller color, lost its turgor (skin became pliable and leathery) and pitting and other skin blemishes were more abundant.

To determine the rate at which the fruit deteriorated after removal from "still air" cold storage to outside or fruitstand temperatures, five boxes of fruit from the various lots were removed after eight weeks from the "tank" (37° F.) to 58° F. and were inspected and tasted after 10, 17 and 22 days respectively. One box of Valencia oranges and four boxes of Marsh Seedless grapefruit of different sizes were used for this experiment. These data are shown graphically in Fig. 7.

The oranges kept better than the grapefruit after removal from storage, showing over 60% good fruit after 22 days. The smaller sizes of grapefruit (80's and 70's) were equivalent to this after only 10 days and lost considerable value after two and three weeks.

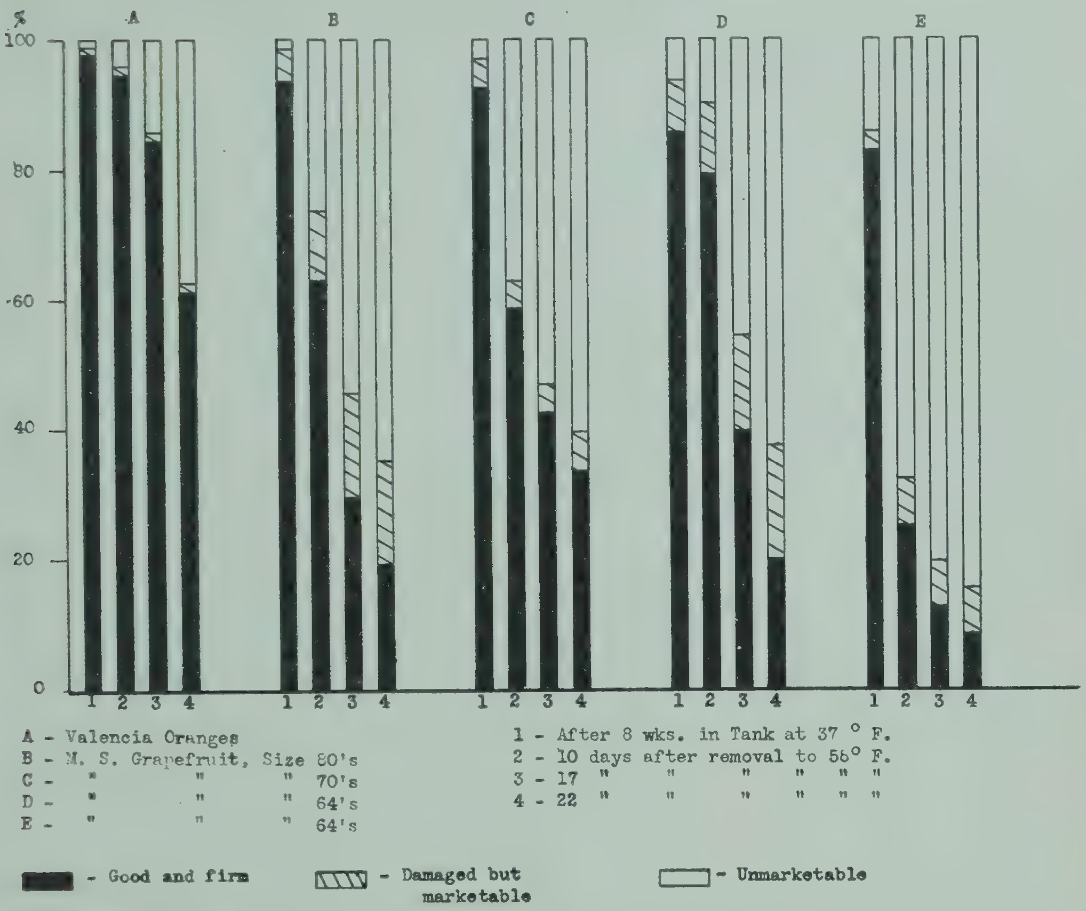

Fig. 7.—Rate of deterioration of Marsh Seedless grapefruit and Valencia oranges after removal from air-tight storage at 37° F. to open shelves at 58° F.

The general conclusions are that oranges kept considerably better than grapefruit, both during storage and after removal from storage, as has been noted before (*15*, *16*) and that Valencia oranges can be held without serious loss[7] for two weeks at normal temperatures after being stored for two months in "still air" storage at 37° F. Grapefruit are more vulnerable to physiological deterioration after removal from storage, one week being about the holding limit to prevent serious loss after storage. The larger sizes of fruit seem to be more vulnerable to losses during and after storage than the smaller sizes.

These figures compare favorably with the after-storage holding period of fruit stored in rooms refrigerated by forced air circulation, as reported by Stahl and Camp (*15*).

The physical condition of fruit is much better, both during and after storage, when "still air" and controlled ventilation methods of storage are used at 37° F. These results were further confirmed the following year with fruit stored in the

---

[7] About 20% loss for three months' holding is considered the limit for commercial efficiency.

TABLE 8.—EFFECT OF CONTROLLED VENTILATION ON THE MARKETABILITY OF SEVERAL VARIETIES OF CITRUS FRUITS AFTER TWO AND FOUR MONTHS' STORAGE AT 37° F.

Name	Source	No. of boxes used*	Forced Air Circulation				Still Air			
			% Unmarketable**		Pit Value	General Condition	% Unmarketable		Pit Value	General Condition
			After 2 mos.	After 4 mos.			After 2 mos.	After 4 mos.		
Pineapple oranges	Chinsegut Hill	18	0.5	1.3	88.7	Slightly soft	0.1	1.0	89.6	Firm and good
Valencia oranges	Chinsegut Hill	26	0.2	0.8	87.8	Slightly soft	0.1	0.2	89.2	Firm and good
Pineapple oranges	Lake Alfred	20	0.0	1.2	85.6	Slightly soft	0.0	0.1	90.0	Firm and good
Valencia oranges	Lake Alfred	20	0.2	2.5	90.1	Slightly soft	0.1	1.2	90.6	Firm and good
Homosassa oranges	Lake Alfred	28	2.7	33.6	88.9	Slightly soft	2.4	19.5	90.5	Firm and good
Average for round oranges		112	0.7	7.9	88.2	Slightly soft	0.5	4.4	90.0	Firm and good
Florida Common grapefruit	Chinsegut Hill	34	0.2	2.2	67.3	Slightly soft	0.1	0.6	89.1	Firm and good
Excelsior grapefruit	Chinsegut Hill	18	0.6	1.2	88.9	Fair	0.0	0.7	91.0	Firm and good
Silver Cluster grapefruit	Lake Alfred	74	0.5	17.7	58.1	Slightly soft	0.0	4.7	89.4	Firm and good
Average for grapefruit		126	0.4	7.0	71.4	Slightly soft	0.0	2.0	89.8	Firm and good
Temple oranges	Lake Alfred	8	2.5	11.8	93.0	Soft and dry	2.5	6.2	94.5	Firm and good
Thornton Tangelos	Lake Alfred	10	0.5	3.5	91.6	Soft and dry	0.7	2.4	94.8	Firm and good
Total Average		256	0.8	7.6	84.0	Slightly soft	0.6	3.7	90.9	Firm and good

*This number of boxes was divided equally between the two atmospheric conditions used.

**Due to physiological causes.

"tank" room. This time the experiment was outlined primarily for a comparison of pre-treatments on fruit before storing, but the data obtained are valuable here in confirming the fact that both oranges and grapefruit remained in much better physical condition, maintained a higher juice content and had a much better appearance as to pitting, color, firmness, etc., than those stored in the continuously ventilated storage room.

Table 8 shows the average percent of unmarketable fruit, the relative degree[8] of pitting, and the general condition of a large number of fruit of several varieties stored in "still air" and in an open room with forced air circulation at 37° F. In every instance there was a marked increase in the number of marketable fruit, as well as a better quality in texture, in the "tank" room or "still air" storage over the duplicates in the open room, or continuously ventilated storage.

TABLE 9.—EFFECT OF FORCED AIR CIRCULATION ON THE LOSS OF WEIGHT OF MARSH SEEDLESS AND SILVER CLUSTER GRAPEFRUIT AT 37° F.

Marsh Seedless (after 8 weeks)					Silver Cluster		
Treatment No.*	Forced Air Circulation		Still Air		Time in Storage	Total % Loss of Weight*	
	No. of boxes used	% Loss of Weight	No. of boxes used	% Loss of Weight		Forced Air Circulation	Still Air
1	2	2.51	2	0.20	1 week	2.04	1.16
2	1	3.00	1	0.38	2 weeks	3.18	1.20
3	1	3.55	1	0.55	3 weeks	4.28	1.31
4	2	4.08	2	0.61	4 weeks	5.53	1.35
5	2	5.12	4	0.81	5 weeks	6.21	1.44
6	1	6.22	1	0.65	6 weeks	8.38	1.68
7	2	6.82	4	0.95	7 weeks	9.68	1.84
8	1	8.03	2	1.30	8 weeks	11.88	1.99
Total No. Boxes	12	......	17	......	Average Loss per week	1.49	0.25
Average	....	4.82	....	0.76	*Each figure is an average of 30 fruit		

*The treatments are not to be considered here.

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[8] The "pit value" here shows the relative degree of pitting, based on an arbitrary scale showing a pit value of 100 = no pitting, and a pit value of 40 = very severe pitting. These were estimated for individual fruit and the pit value for each box calculated by averages.

There was also a definite decrease in the degree of pitting of fruit stored in the "tank" (still air).

Table 9 shows the loss of weight of grapefruit in boxes (Marsh Seedless) and on shelves (Silver Cluster) after eight weeks' storage in the continuously ventilated storage room as compared to that in the "tank" at 37° F. The figures on Marsh Seedless grapefruit are averages of from one to four boxes, weighed separately at the beginning and end of the storage period (eight weeks) and those on Silver Cluster grapefruit are averages of 30 fruit weighed individually every week during the storage period. In both cases the ratio of the weight lost in the "tank" to that lost in the open room was about the same, i. e., the fruit in the continuously ventilated storage room lost about six times as much weight as those in the "tank" room or still air storage.

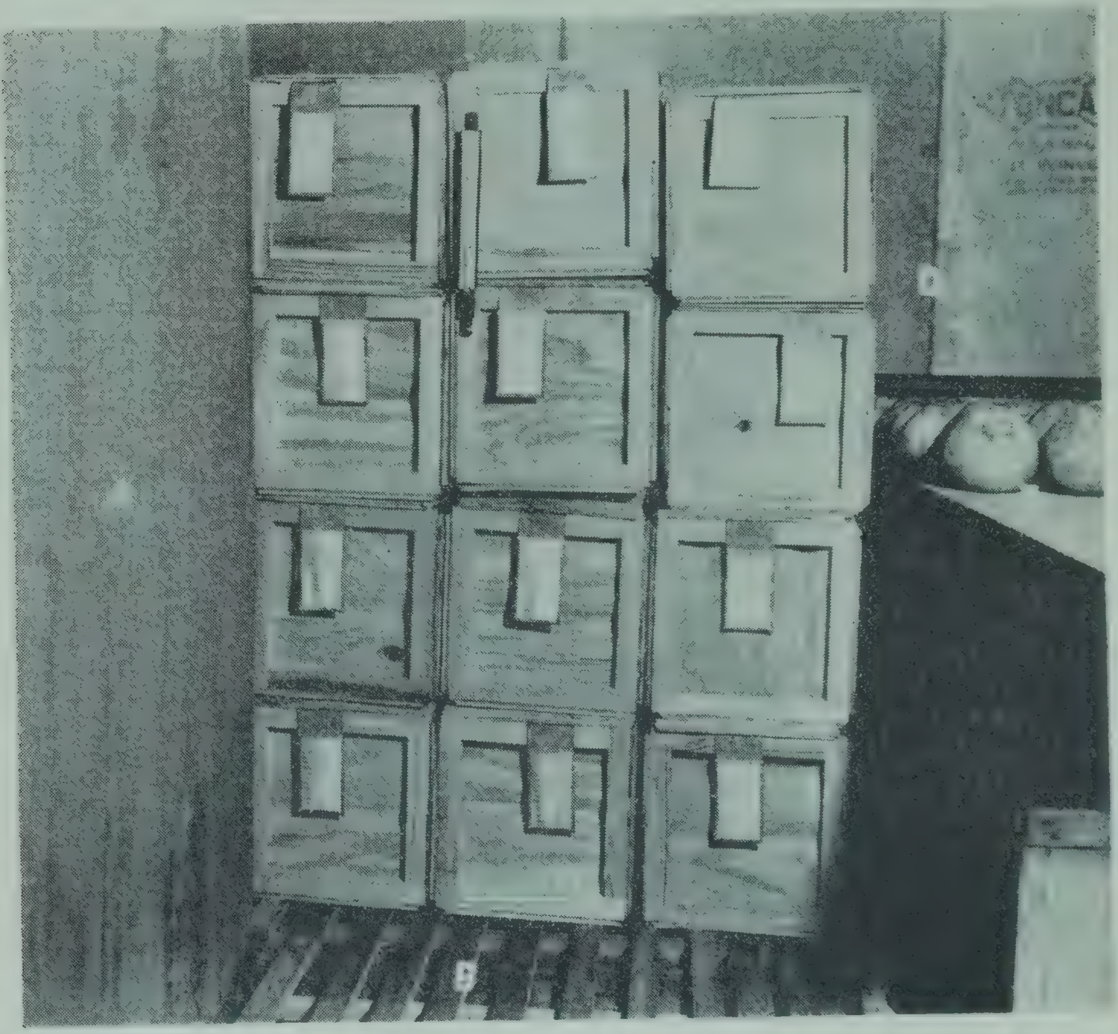

Fig. 8.—Interior of sheet iron "tank room", showing air chute (A) which passes vertically through the middle of the tank; the slatted floor (B); packed boxes of fruit (C); the rear wall of the tank (D), and the shelf (E) containing unpacked fruit.

Fig. 8 shows the interior of the "tank" storage room with boxes of fruit and fruit on a shelf inside.

Later a more practical modification of this type of storage condition was tried. This consisted of merely covering a stack of boxes containing fruit with a large tarpaulin made from 10 oz. duck. The tarpaulin was moistened from time to time to keep the humidity as high as possible beneath it. The tarpaulin prevented air circulation about the fruit, maintained a higher humidity than the regular storage room, and provided sufficient ventilation to prevent the accumulation of high concentrations of respiratory gases.

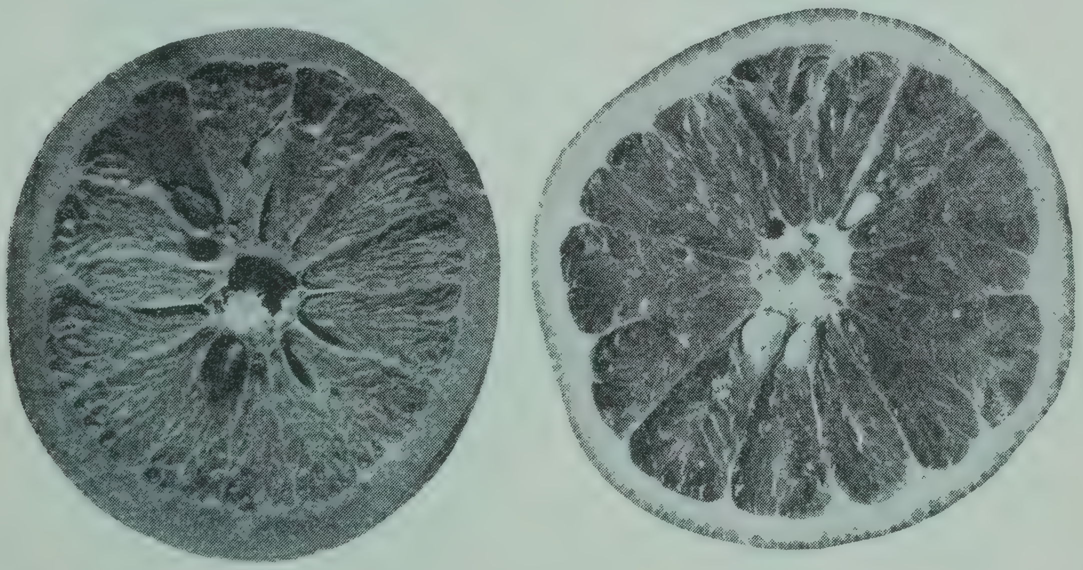

Fig. 9.—Silver Cluster grapefruit. Left—Cut half of "soggy" fruit developed after two months' storage in CO_2 gas at 37° F. Right—Cut half of good fruit after three months' storage in "still air" (air-tight container ventilated at weekly intervals) at 37° F.

Results from 20 boxes of fruit stored under tarpaulins at each of two temperatures, 33° F. and 37° F., showed 94.3% and 92.5% good marketable fruit after three months' storage. The loss of weight of fruit under the tarpaulin was about one-third that of fruit stored in the same room without the tarpaulin cover.

This type of storage condition has about the same moisture retentiveness as that of a semi-moistureproof wrapper on the fruit (*16*).

There are dangers, however, that cannot be overlooked when storing fruit in this type of storage room. If the fruit is infected with mold spores, stem-end rot fungi or other organisms causing decay at the time of storage they deteriorate just as fast and, under some conditions, faster in this highly humid storage atmosphere than in the continuously ventilated storage room used in these experiments. Not only are serious losses

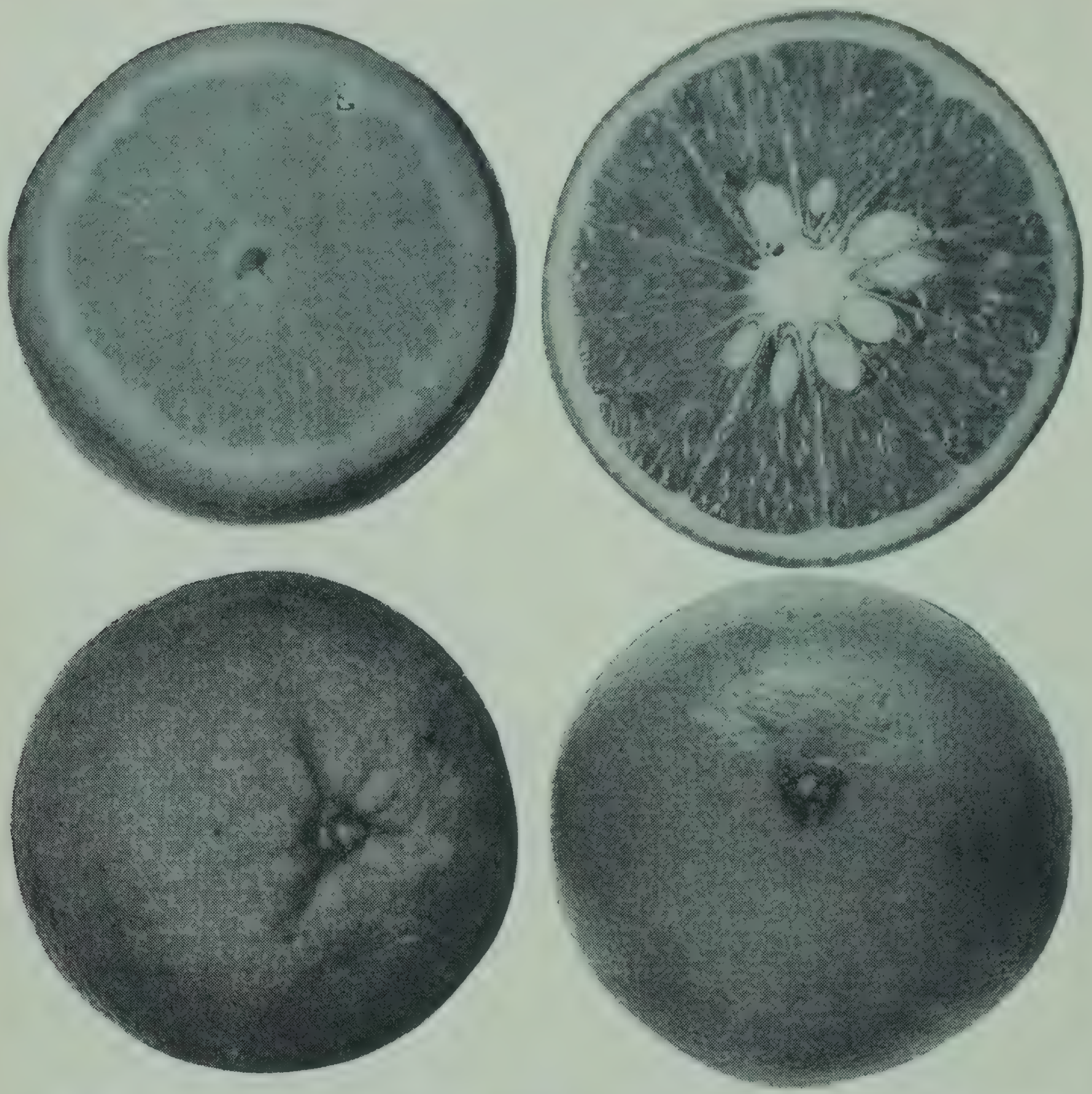

Fig. 10.—Left—Homosassa orange showing "soggy" condition developed by storage in CO_2 gas. Right—Pineapple orange stored in "tank" room frequently ventilated. Note the dull, dead appearance of the soggy fruit and the glossy luster of the good fruit.

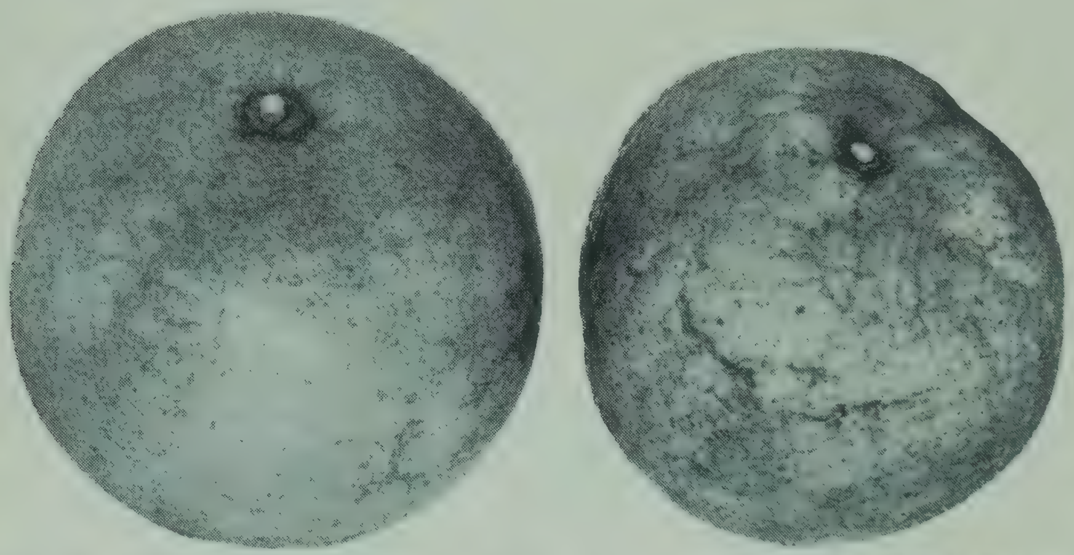

Fig. 11.—Valencia orange stored in "tank" room frequently ventilated (left) and in a continuously ventilated storage room (right).

effected in this way, but the presence of this decaying fruit within a closed system of this sort will very rapidly increase the CO_2 content to a dangerous point and thus cause the uninfected fruits to become "soggy" or dead, unless properly ventilated.

Sogginess can be produced in fresh fruit within two weeks after storing with CO_2 gas or if the respiratory gases are allowed to accumulate in a closed container.

SUMMARY

The effects of several gaseous atmospheres and humidity conditions on citrus fruits in cold storage were studied.

Loss of weight, firmness and pitting were found to be greatly affected by the humidity of the atmosphere, a high humidity being most desirable.

Both taste and texture of grapefruit were affected by the gaseous constituent of the atmosphere, O_2 and CO_2 proving deleterious in high concentrations.

Pitting seemed to be increased by O_2 and slightly decreased by N_2 gas over ordinary air. Small amounts of CO_2 seem favorable in reducing pitting.

"Sogginess" was definitely produced by CO_2 gas and no success was obtained in reviving fruit, after sogginess began, by treatment with O_2 gas.

Fruit stored in N_2 gas developed a "musty", disagreeable taste, but the fruit maintained its firmness and bright color.

Forced air circulation in the storage room is deleterious to the texture and longevity of storage life and increases the loss in weight of citrus fruit in storage.

Fruit stored in a closed system (still-air storage) low in CO_2 and O_2 content (about 6 and 12 percent respectively) and high in relative humidity at 37° F. can be kept in good physical condition for four months.

The storage life of oranges and grapefruit was successfully lengthened and the physical condition maintained better in a specially constructed still-air storage room with controlled ventilation. This cold storage room can be operated successfully on a commercial scale.

Similar conditions can be effected by covering the stack of boxes of fruit with a canvas tarpaulin.

The ventilation of such a storage room must be carefully controlled to prevent the accumulation of high concentrations of respiratory gases. If allowed to accumulate, these gases cause serious atmospheric deficiencies which, in turn, cause physiological breakdown of the fruit.

In storing citrus fruit by this method, the utmost precaution should be taken to prevent infection by organisms causing decay before storage, and proper ventilation effected to prevent the accumulation of high concentrations of respiratory gases.

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A METHOD FOR MEASURING CO_2 RESPIRED BY CITRUS FRUITS

A Preliminary Report

By John C. Cain

Since respiration plays an important role in the keeping quality of citrus fruits in cold storage and also in maintaining proper atmospheric conditions in storage, a suitable and accurate method for measuring the CO_2 output of citrus fruits has been devised.

This method consists of an air-tight circulation system through a respiration chamber containing the fruit under investigation. The respiration chamber is large enough to hold 15 to 18 average size oranges (and 10 to 12 average size grapefruit—Fig. 12). The air is circulated through the system by a small air pump that will deliver two liters of air per minute and develop about one pound pressure. The air is expelled from the air pump into the top of the respiration chamber, where it is diffused by a perforated disk seated in the lid of the chamber. The air slowly moves downward over the fruit, carrying with it the CO_2 respired by the fruit and is expelled through an outlet tube from the bottom of the chamber into the bottom of a flask containing standard barium hydroxide, $Ba(OH)_2$, which absorbs the CO_2 very rapidly. The air moves from the flask containing the absorbing solution through an outlet tube that returns it to the air pump. A one-way valve is inserted in the line between the absorbing solution and the air pump to admit enough air from the outside to equalize the diminished pressure caused by the absorption of the CO_2. This air coming into the system is freed of CO_2 by a soda-lime tube in part of the valve, hence the air within the system is not contaminated with atmospheric CO_2.

In making a determination, the air is allowed to circulate through the system into a quantity of absorbing solution for several minutes, then this is replaced by a measured quantity of standard $Ba(OH)_2$ solution and the air allowed to circulate for a measured length of time. The standard $Ba(OH)_2$ absorbing solution is then titrated against standard HCl and the quantity of CO_2 absorbed is calculated.

In this way the rate at which CO_2 is evolved can be measured

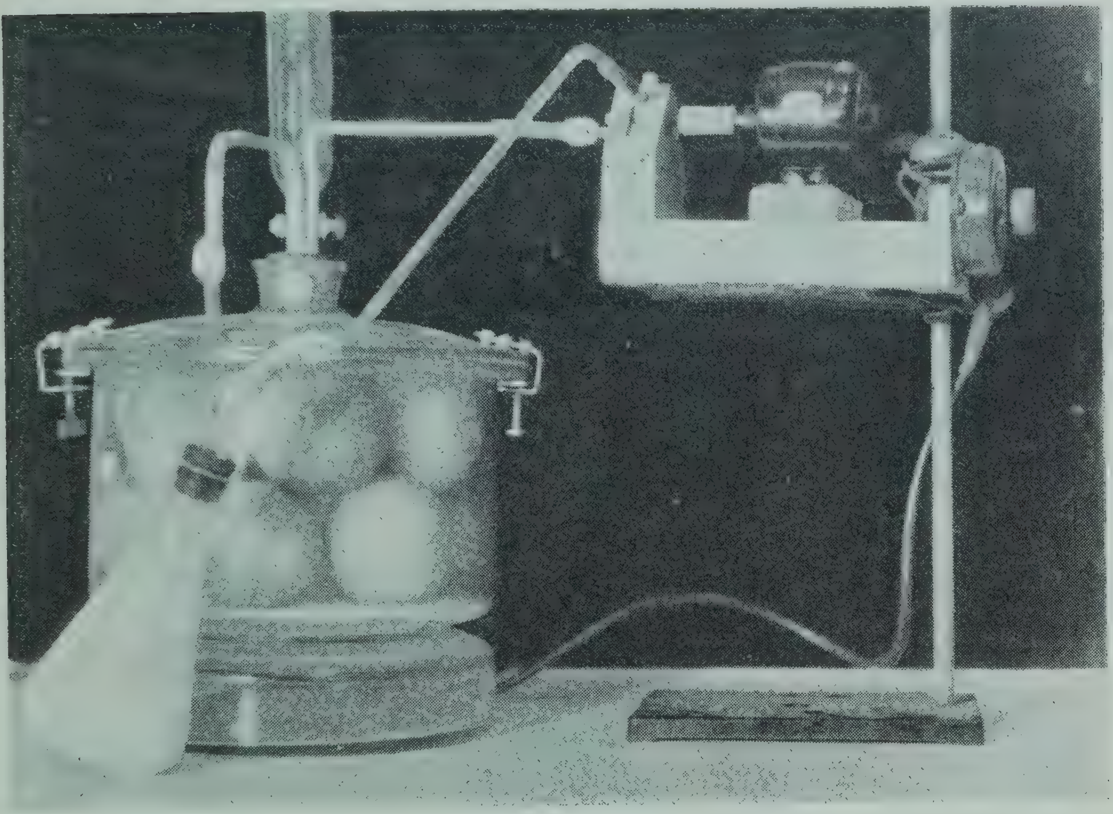

Fig. 12.—Apparatus for measuring respiration of citrus fruits.
A—Motor for operating air pump "B".
B—Air pump for circulating air through system.
C—Respiration chamber.
D—Absorption flask containing standard $Ba(OH)_2$ for absorbing CO_2.
E—Separatory funnel through which gases or other reagents may be placed in the respiration chamber with the fruit.

for a given quantity of fruit. This may be tabulated on a basis of weight or surface area, as may be desired.

The system may be used with different gaseous atmospheres over the fruit by flushing the system with the desired gas before operations are begun. Results can be obtained with a maximum variation of three milligrams of CO_2 in duplicate determinations of one-half hour duration. This amounts to less than 0.5% error in most cases with citrus fruit.

In connection with the atmosphere in the cold storage room where the fruit is stored, the effect of accumulated respiration gas on the respiration of the fruit was studied. Results show a remarkable decrease in respiration, with an increase in the accumulated respiratory gases that contaminate the atmosphere. In some cases, respiration was only one-tenth (1/10) of its initial rate after three weeks. A very serious physiological condition (sogginess) developed in the fruit in high concentrations of respired gases. Results were about the same in this respect for several different temperatures and commercial surface treatments (brytene, colloidal paraffin, borax, etc.).

Respiration activity declines rapidly with a lowering of temperature.

Respiration measurements on Parson Brown oranges, before, during and after ethylene gas treatment in the packinghouse showed a marked increase in respiration while exposed to ethylene gas and a decrease to below normal 12 hours after removal from the ethylene treatment. These fruits returned to normal respiratory activity after two days.

Bulletin 317 November, 1937

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AGRICULTURAL EXPERIMENT STATION
WILMON NEWELL, Director
GAINESVILLE, FLORIDA

FLORIDA CITRUS PRICES, II

By

A. H. SPURLOCK AND MARVIN A. BROOKER

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FLORIDA CITRUS PRICES, II

By A. H. Spurlock and Marvin A. Brooker[1]

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This bulletin covers the second phase of a study of Florida citrus prices, the first phase of which appeared in Bulletin 315 of this station. The purpose of this bulletin is to show the average costs of marketing Florida citrus fruit at auction according to method of preservation[2] used in shipment to market, and to show comparative auction prices received for fruit shipped under the various methods of preservation.

As in Bulletin 315, shipments of citrus fruit from 31 Florida packinghouses sold at auction in New York, Chicago, Detroit, Cincinnati and Pittsburgh are included in the data. No shipments of bulk fruit or shipments of packed fruit by express or by motor truck alone have been used.

The individual shipment manifest of each lot of citrus from which data were taken showed the point of origin, destination, route of shipment, method of preservation used, date shipped and date sold, number of boxes and price per box for each variety, grade and size of fruit. The number of boxes in each variety, grade, and size was multiplied by the price per box of the particular lot, and the value tabulated to the nearest even

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Acknowledgments: The writers wish to express their thanks to all who have assisted in the preparation of this work. Special credit is due Dr. C. V. Noble under whose direction the study was made, and to Dr. H. G. Hamilton who assisted in outlining the work and offered helpful criticism. Appreciation is also due Mr. Zach Savage for his aid.

The Farm Credit Administration of Columbia cooperated in the completion by furnishing the use of Hollerith electric sorting and tabulating equipment, and operators, at Columbia, South Carolina.

Records from which data were taken were kindly made available by the Florida Citrus Exchange, Tampa, and the Florida Division of the American Fruit Growers, Inc., Orlando.

[1] Chief Statistician, Farm Credit Administration, Columbia, South Carolina.

[2] Preservation as used in this text refers to pre-cooling and refrigeration by various means and to standard ventilation.

TABLE 1.—VOLUME OF AUCTION SALES OF FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES TO FIVE MARKETS.

Market	1930-31		1931-32		1932-33		Total	
	Number of boxes	Percent of total	Number of boxes	Percent of total	Number of boxes	Percent of total	Number of boxes	Percent of total
New York	941,106	60.9	834,610	71.6	830,629	69.9	2,606,345	66.8
Chicago	312,423	20.2	170,465	14.6	164,637	13.9	647,525	16.6
Detroit	131,724	8.5	76,347	6.5	91,571	7.7	299,642	7.7
Cincinnati	94,823	6.2	57,715	5.0	69,187	5.8	221,725	5.7
Pittsburgh	64,392	4.2	26,889	2.3	32,250	2.7	123,531	3.2
Total	1,544,468	100.0	1,166,026	100.0	1,188,274	100.0	3,898,768	100.0

TABLE 2.—VOLUME OF NEW YORK AUCTION SALES OF FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES, BY ROUTE OF SHIPMENT.

Route of shipment	1930-31		1931-32		1932-33		Total	
	Number of boxes	Percent of total	Number of boxes	Percent of total	Number of boxes	Percent of total	Number of boxes	Percent of total
Rail	931,997	99.0	681,893	81.7	353,605	42.6	1,967,495	75.5
Rail and water	7,954	.9	7,260	.9	117,414	14.1	132,628	5.1
Motor truck and water	1,155	.1	145,457	17.4	359,610	43.3	506,222	19.4
Total	941,106	100.0	834,610	100.0	830,629	100.0	2,606,345	100.0

dollar. All sizes in the same grade and variety were later added together to obtain larger groups for comparison.

Unless otherwise stated, all containers were converted to the equivalent number of standard boxes of one and three-fifths bushels. This is the customary package for oranges and grapefruit, although tangerines and Temples are usually shipped in half-boxes or in bushel baskets.

Because of the small amount of fruit moving at the beginning, and at the end of the season, September and October have been combined; also July and August.

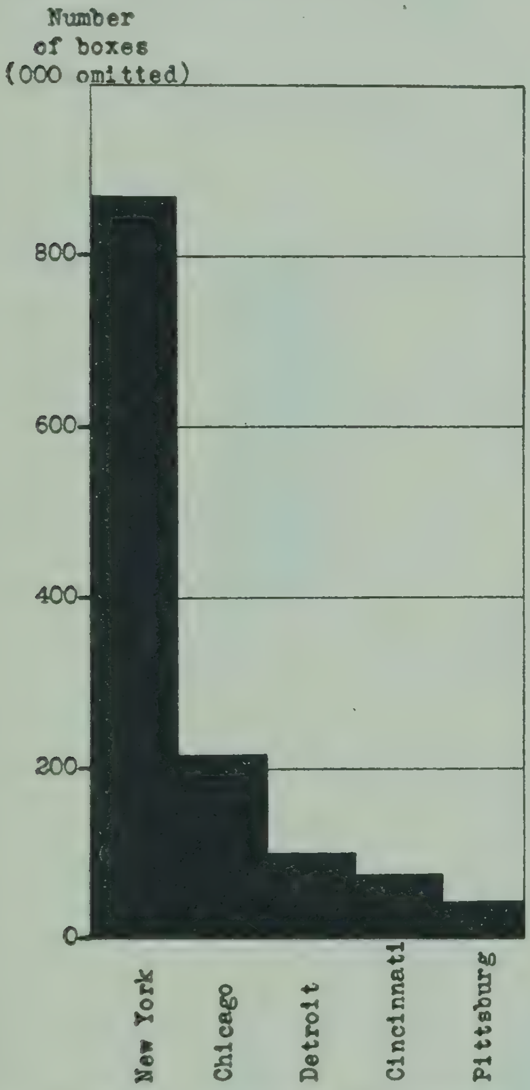

Fig. 1.—Volume of auction sales of citrus fruit from 31 Florida packinghouses to five markets (average of three seasons, 1930-31, 1931-32, and 1932-33).

RELATIVE IMPORTANCE OF MARKETS STUDIED

The relative importance of the five markets to the 31 packinghouses from the standpoint of volume of auction sales in each is shown in Table 1, and Fig. 1. New York received during the three seasons approximately twice as much fruit as the four other markets combined.

ROUTES OF SHIPMENT

Shipments were made to Chicago, Detroit, Cincinnati and Pittsburgh by rail only, but New York received fruit by other routes also, as shown in Table 2. In 1930-31 rail shipments made up 99 percent of the total shipments to New York from the 31 packinghouses; in 1932-33 less than half the auction sales in New York were shipped by rail alone (Fig. 2).

The most common practice in rail and water shipment was to send the fruit to Jacksonville by rail, thence to New York by water. In motor truck and water shipments the fruit was

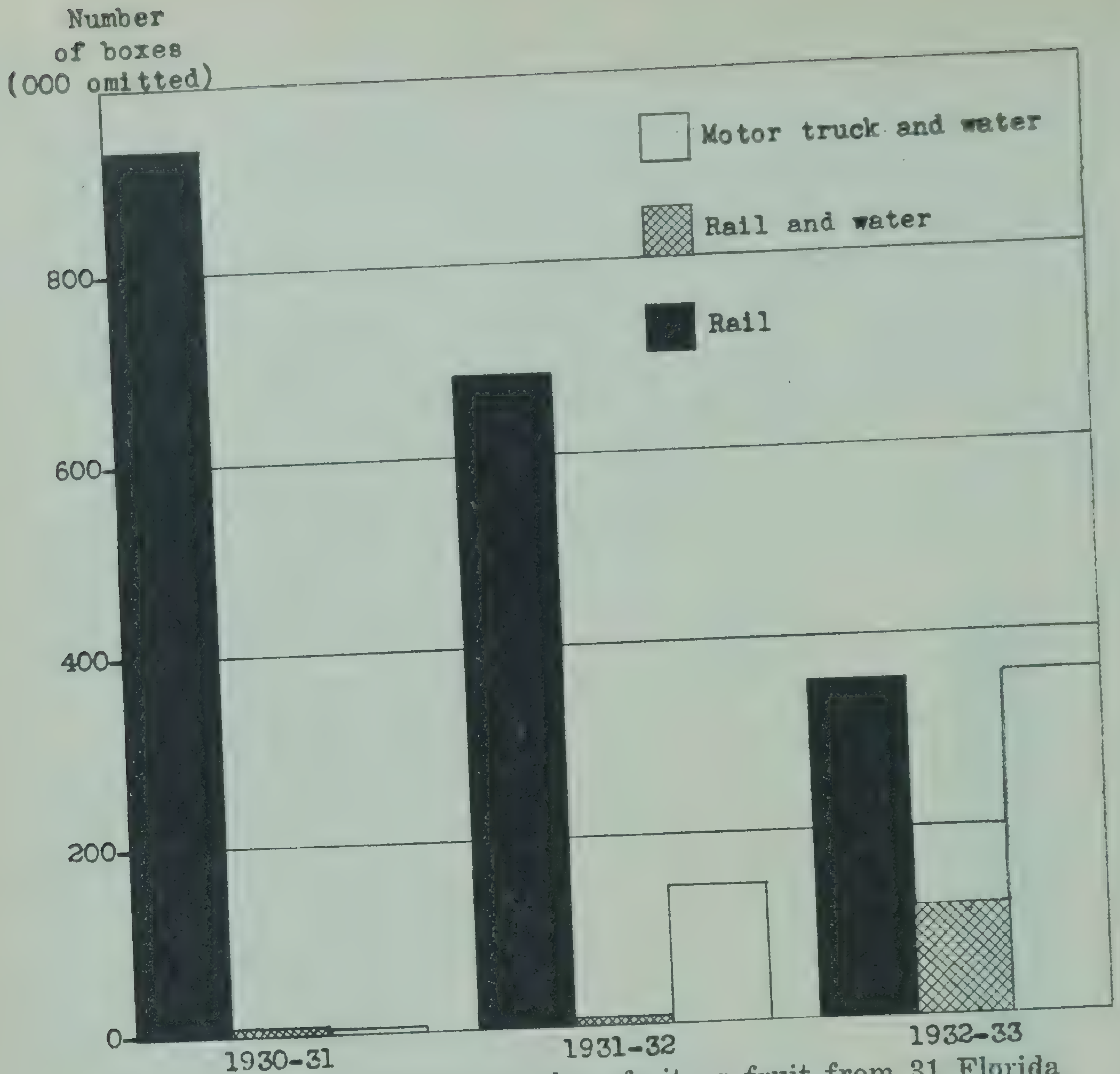

Fig. 2.—New York auction sales of citrus fruit from 31 Florida packinghouses, by route of shipment.

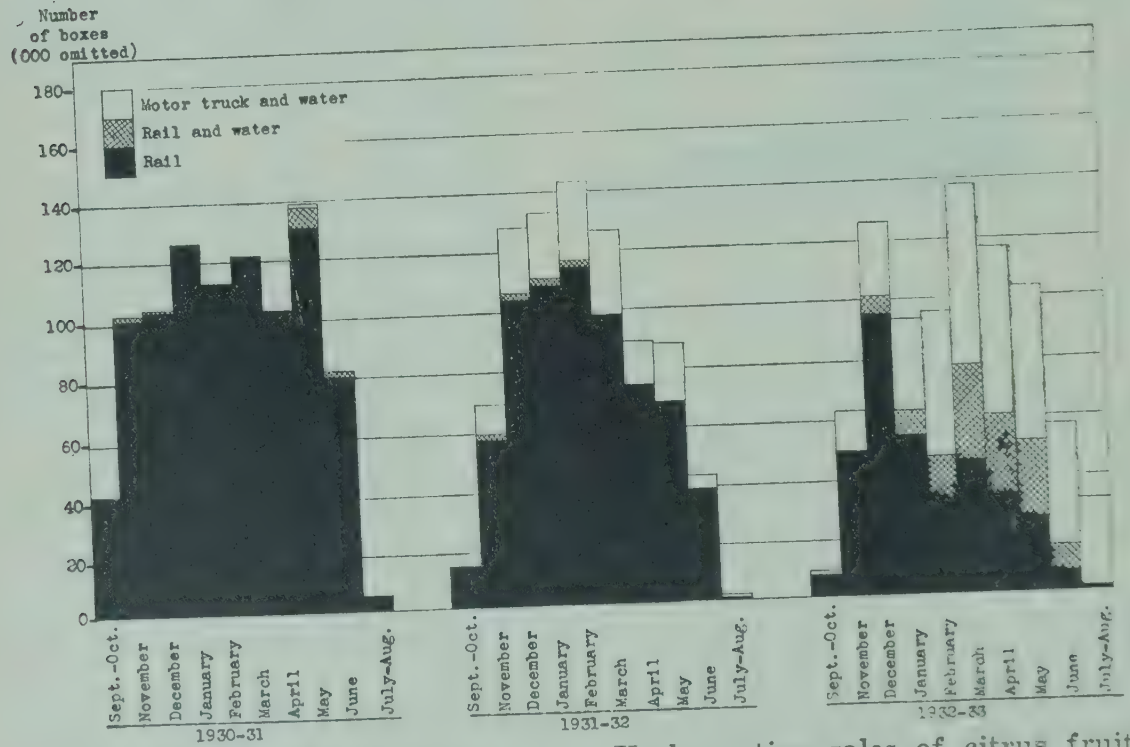

Fig. 3.—Seasonal distribution of New York auction sales of citrus fruit from 31 Florida packinghouses, by route of shipment.

TABLE 3.—SEASONAL DISTRIBUTION OF NEW YORK AUCTION SALES OF FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES, BY ROUTE OF SHIPMENT.

Month sold	1930-31				1931-32				1932-33			
	Rail	Rail and water	Motor truck and water	Total	Rail	Rail and water	Motor truck and water	Total	Rail	Rail and water	Motor truck and water	Total
	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)
Sept.-Oct.	41,981			41,981	14,247			14,247	8,173		400	8,573
November	101,212	692		101,904	57,527	1,832	8,632	67,991	49,641		12,722	62,363
December	103,726	31		103,757	104,702	1,343	21,930	127,975	95,486	4,952	25,527	125,965
January	127,216			127,216	109,279	1,910	21,578	132,767	54,141	8,057	31,061	93,259
February	113,345			113,345	114,503	2,175	26,603	143,281	31,998	14,014	49,180	95,192
March	122,154			122,154	98,697		27,405	126,102	45,168	31,431	61,458	138,057
April	103,871			103,871	74,566		14,602	89,168	33,756	26,104	56,162	116,022
May	131,996	6,144	1,155	139,295	68,484		19,815	88,299	25,749	25,276	52,605	103,630
June	80,501	1,087		81,588	38,625		4,449	43,074	7,955	7,580	41,081	56,616
July-Aug.	5,995			5,995	1,263		443	1,706	1,538		29,414	30,952
Total	931,997	7,954	1,155	941,106	681,893	7,260	145,457	834,610	353,605	117,414	359,610	830,629
Percent each route	99.0	0.9	0.1	100.0	81.7	0.9	17.4	100.0	42.6	14.1	43.3	100.0

TABLE 4.—AUCTION SALES IN FIVE MARKETS OF FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES, BY ROUTE, AND BY METHOD OF PRESERVATION USED.

Method of preservation	Rail shipments															
	New York				Chicago				Detroit				Cincinnati			
	1930-31	1931-32	1932-33	Total	1930-31	1931-32	1932-33	Total	1930-31	1931-32	1932-33	Total	1930-31	1931-32	1932-33	Total
	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)
Pre cooled	63,578	3,852	1,644	69,074	7,726	804	....	8,530	2,172	....	....	2,172	1,530	384	....	1,914
Initially iced	124,719	114,290	56,895	295,904	22,346	22,946	20,848	66,140	8,098	9,677	18,578	36,353	12,976	9,698	13,020	35,694
Pre cooled and initially iced	338,475	234,225	144,457	717,157	106,162	56,800	78,806	241,768	43,914	15,864	23,911	83,689	26,482	16,261	17,968	60,711
Pre-cooled and standard refrigeration	11,901	....	....	11,901	720	....	....	720	....	....	....	....	....	....	....	....
Standard refrigeration	117,118	100,734	46,273	264,125	45,873	20,816	24,473	91,162	28,170	16,296	16,884	61,350	16,007	9,709	13,947	39,663
Standard ventilation	276,206	228,792	104,336	609,334	129,596	69,099	40,510	239,205	49,370	34,510	32,198	116,078	37,828	21,663	24,252	83,743
Total	931,997	681,893	353,605	1,967,495	312,423	170,465	164,637	647,525	131,724	76,347	91,571	299,642	94,823	57,715	69,187	221,725

Method of preservation	Rail shipments				Rail and water shipments				Motor truck and water shipments			
	Pittsburgh				New York				New York			
	1930-31	1931-32	1932-33	Total	1930-31	1931-32	1932-33	Total	1930-31	1931-32	1932-33	Total
	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)
Pre-cooled	2,544	444	....	2,988	5,110	....	16,518	21,628	....	303	59,358	59,661
Initially iced	8,081	5,275	4,095	17,451	1,394	....	....	1,394	....	....	....	....
Pre-cooled and initially iced	27,550	3,992	9,219	40,761	....	752	757	1,509	....	....	....	....
Pre-cooled and standard refrigeration	....	372	....	372	....	....	....	....	....	....	....	....
Standard refrigeration	6,484	3,997	7,093	17,574	....	....	....	....	....	....	....	....
Standard ventilation	19,733	12,809	11,843	44,385	1,450	6,508	100,139	108,097	1,155	145,154	300,252	446,561
Total	64,392	26,889	32,250	123,531	7,954	7,260	117,414	132,628	1,155	145,457	359,610	506,222

frequently sent to Jacksonville or Tampa by motor truck and from these ports to New York by water. Other loading points for motor truck and water shipments were also used, particularly at Sanford and DeLand, on the St. Johns River. No motor truck shipments from the point of origin to the auction market were included.

A seasonal distribution of auction sales in New York by route of shipment is shown in Table 3, and Fig. 3. The lower prices received for Florida citrus in 1932-33 than in the preceding two seasons may have been responsible for the tremendous increase in the use of the cheaper water routes to New York that season.

METHODS OF PRESERVATION USED

The most common methods of preservation used in rail shipments to the five markets were pre-cooling and initial icing combined, and standard ventilation, i. e. no refrigeration (Table 4). These two methods together averaged 68.6 percent of the total volume shipped by rail during the three seasons (Fig. 4). Two other methods of importance were standard refrigeration, and initial icing. Pre-cooling alone seems to have been little used, and was used less after the 1930-31 season (Table 4).

The three-season monthly total auction sales in each market by route of shipment and by method of preservation used is shown in Table 5. A monthly percentage distribution of rail shipments to the five markets by means of preservation used is shown in Table 6.

Standard ventilation was used mainly in the cooler months, November through April, while in the hotter months there was an increased use of standard refrigeration, and of pre-cooling and initial icing. This latter method was fairly important the year round, based on the percentage of the total shipments each month by that method.

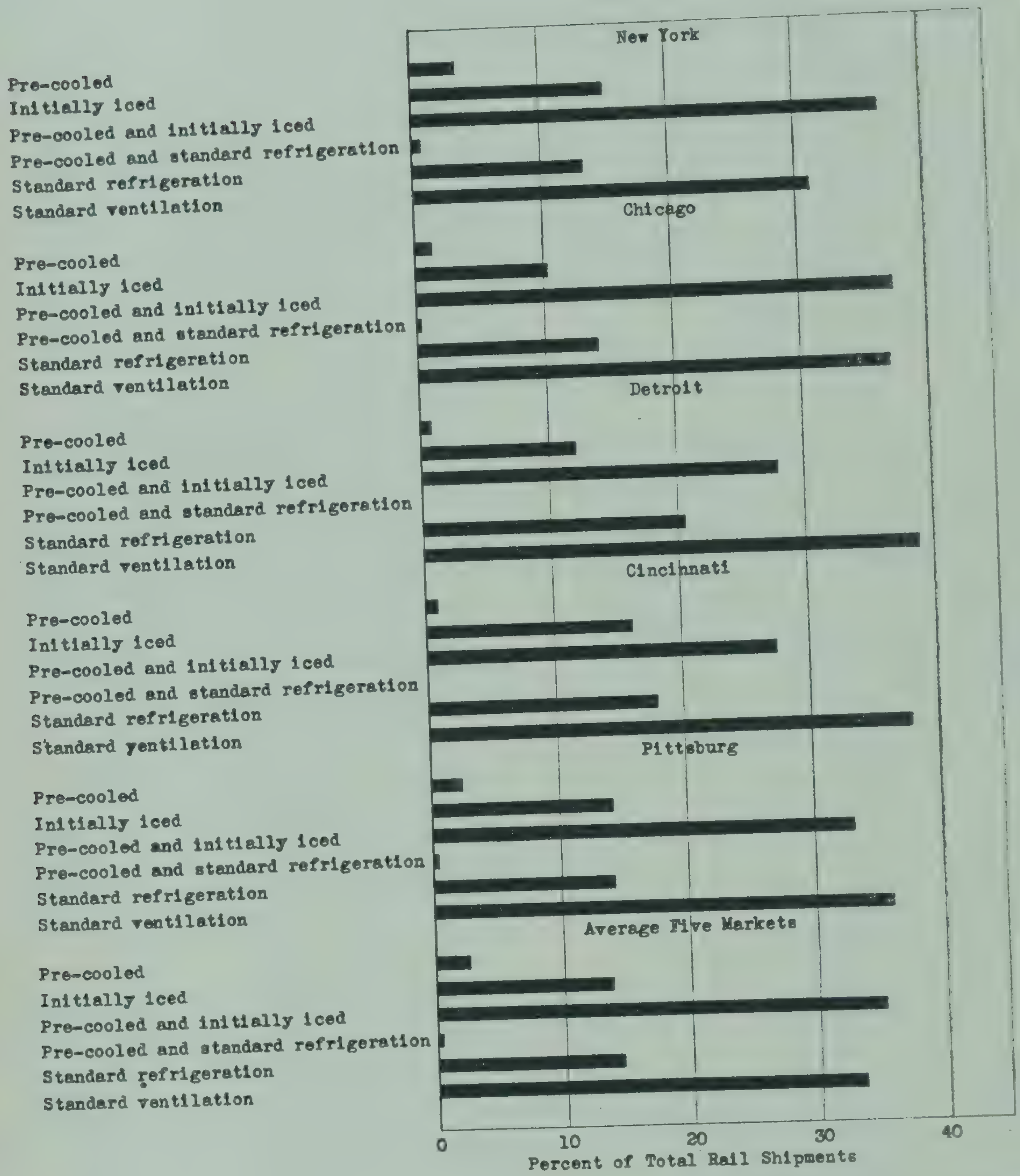

Fig. 4.—Volume of auction sales in five markets of Florida citrus fruit from 31 packinghouses by method of preservation used, rail shipments only (average of three seasons, 1930-31, 1931-32, and 1932-33).

TABLE 5.—SEASONAL DISTRIBUTION OF AUCTION SALES OF FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES TO FIVE MARKETS, BY ROUTE OF SHIPMENT AND BY METHOD OF PRESERVATION USED.

(Total of three seasons, 1930-31, 1931-32, and 1932-33)

Month sold	Rail shipments													
	New York							Chicago						
	Pre-cooled	Initially iced	Pre-cooled and initially iced	Pre-cooled and standard refrig-eration	Standard refrig-eration	Standard ventila-tion	Total	Pre-cooled	Initially iced	Pre-cooled and initially iced	Pre-cooled and standard refrig-eration	Standard refrig-eration	Standard ventila-tion	Total
	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)
September-October	....	7,583	23,756	....	30,866	2,196	64,401	....	2,618	9,020	....	16,366	360	28,364
November	2,520	33,947	65,986	....	51,150	54,777	208,380	2,572	8,438	23,509	....	15,483	15,735	65,737
December	7,460	48,805	125,401	....	27,653	94,595	303,914	....	7,589	30,376	....	8,871	36,043	82,879
January	12,031	44,246	91,341	....	29,262	113,756	290,636	2,172	8,220	28,980	....	7,547	45,474	92,393
February	12,033	26,929	87,098	....	29,860	103,926	259,846	....	5,478	27,704	....	6,373	42,293	81,848
March	19,049	34,473	79,128	....	13,202	120,167	266,019	1,176	3,499	19,519	....	2,345	49,571	76,110
April	11,882	30,810	67,795	....	13,876	87,830	212,193	2,250	9,426	28,901	....	5,255	39,415	85,247
May	3,379	54,810	98,422	....	39,355	30,263	226,229	360	17,848	51,951	....	17,165	10,314	97,638
June	720	11,496	77,126	10,781	25,518	1,440	127,081	....	3,024	21,060	720	9,414	....	34,218
July-August	....	2,805	1,104	1,120	3,383	384	8,796	....	....	748	....	2,343	....	3,091
Total	69,074	295,904	717,157	11,901	264,125	609,334	1,967,495	8,530	66,140	241,763	720	91,162	239,205	647,525
Percent of total	3.5	15.0	36.5	.6	13.4	31.0	100.0	1.3	10.2	37.3	.1	14.1	37.0	100.0
	Detroit							Cincinnati						
September-October	....	2,244	2,952	....	8,823	....	14,019	....	1,812	1,549	....	3,320	1,452	8,133
November	360	6,482	9,615	....	8,664	7,013	32,134	720	2,211	3,330	....	8,446	8,483	23,190
December	....	3,468	10,580	....	3,703	19,727	37,478	....	5,353	8,977	....	3,643	10,866	28,839
January	....	4,194	8,781	....	6,657	22,134	41,766	....	6,044	8,597	....	4,448	14,807	33,896
February	....	3,424	9,054	....	5,116	17,671	35,265	....	5,432	7,438	....	4,578	12,854	30,302
March	372	1,836	6,988	....	2,604	24,939	36,739	384	1,574	3,487	....	....	16,924	22,369
April	720	4,410	6,774	....	5,198	16,381	33,483	450	3,668	7,217	....	2,249	12,762	26,346
May	720	7,970	16,498	....	10,464	8,213	43,865	360	8,472	10,932	....	8,532	5,595	33,891
June	....	2,325	11,702	....	9,336	....	23,363	....	1,128	9,184	....	4,447	....	14,759
July-August	....	....	745	....	785	....	1,530	....	....	....	....	....	....	....
Total	2,172	36,353	83,689	....	61,350	116,078	299,642	1,914	35,694	60,711	....	39,663	83,743	221,725
Percent of total	.7	12.1	27.9	....	20.5	38.8	100.0	.8	16.1	27.4	....	17.9	37.8	100.0

TABLE 5.—SEASONAL DISTRIBUTION OF AUCTION SALES OF FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES TO FIVE MARKETS, BY ROUTE OF SHIPMENT AND BY METHOD OF PRESERVATION USED *(Concluded)*.
(Total of three seasons, 1930-31, 1931-32, and 1932-33)

Month sold	Rail shipments							Rail an' water shipments						
	Pittsburgh							New York						
	Pre-cooled	Initially iced	Pre-cooled and initially iced	Pre-cooled and standard refrigeration	Standard refrigeration	Standard ventilation	Total	Pre-cooled	Initially iced	Pre-cooled and initially iced	Pre-cooled and standard refrigeration	Standard refrigeration	Standard ventilation	Total
	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)
September-October	....	1,116	2,350	....	3,258	360	7,084	....	....	....	....	....	....	....
November	720	720	2,544	....	5,066	4,333	13,383	....	....	752	....	....	1,772	2,524
December	732	2,244	4,828	....	1,851	5,141	14,796	....	....	....	....	....	6,326	6,326
January	....	732	4,461	372	763	6,972	13,300	....	....	....	....	....	9,967	9,967
February	360	1,092	2,964	....	....	7,635	12,051	....	....	....	....	....	16,189	16,189
March	1,176	1,116	2,300	....	1,452	8,422	14,466	830	....	757	....	....	29,844	31,431
April	....	1,947	2,233	....	756	7,485	12,421	7,990	....	....	....	....	18,114	26,104
May	....	7,002	11,971	....	3,708	2,597	25,278	10,565	1,394	....	....	....	19,461	31,420
June	....	1,122	7,110	....	720	1,440	10,392	2,243	....	....	....	....	6,424	8,667
July-August	....	360	....	....	....	....	360	....	....	....	....	....	....	....
Total	2,988	17,451	40,761	372	17,574	44,385	123,531	21,628	1,394	1,509	....	....	108,097	132,628
Percent of total	2.4	14.1	33.0	.3	14.2	36.0	100.0	16.3	1.1	1.1	....	....	81.5	100.0

Month sold	Motor truck and water shipments						
	New York						
	Pre-cooled	Initially iced	Pre-cooled and initially iced	Pre-cooled and standard refrigeration	Standard refrigeration	Standard ventilation	Total
	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)	(boxes)
September-October	....	....	....	....	....	400	400
November	....	....	....	....	....	21,354	21,354
December	671	....	....	....	....	46,786	47,457
January	4,730	....	....	....	....	47,909	52,639
February	6,738	....	....	....	....	69,045	75,783
March	4,555	....	....	....	....	84,308	88,863
April	5,975	....	....	....	....	64,789	70,764
May	10,266	....	....	....	....	63,309	73,575
June	12,250	....	....	....	....	33,280	45,530
July-August	14,476	....	....	....	....	15,381	29,857
Total	59,661	....	....	....	....	446,561	506,222
	11.8			....	....	88.2	100.0

TABLE 6.—SEASONAL PERCENTAGE DISTRIBUTION OF AUCTION SALES OF FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES TO FIVE MARKETS, BY RAIL SHIPMENT, AND BY METHOD OF PRESERVATION.

(Total of three seasons, 1930-31, 1931-32, and 1932-33)

Month sold	Pre-cooled		Initially iced		Pre-cooled and initially iced		Pre-cooled and standard refrigeration		Standard refrigeration		Standard ventilation		Total	
	Number of boxes	Per-cent	Number of boxes	Per-cent	Number of boxes	Per-cent	Number of boxes	Per-cent	Number of boxes	Per-cent	Number of boxes	Per-cent	Number of boxes	Per-cent
Sept.-Oct.	....	....	15,373	12.6	39,627	32.5	....	....	62,633	51.3	4,368	3.6	122,001	100.0
November	6,892	2.0	51,798	15.1	104,984	30.6	....	....	88,809	25.9	90,341	26.4	342,824	100.0
December	8,192	1.7	67,459	14.4	180,162	38.5	....	....	45,721	9.8	166,372	35.6	467,906	100.0
January	14,203	3.0	63,436	13.5	142,160	30.1	372	.1	48,677	10.3	203,143	43.0	471,991	100.0
February	12,393	3.0	42,355	10.1	134,258	32.0	....	....	45,927	10.9	184,379	44.0	419,312	100.0
March	22,157	5.4	42,498	10.2	111,422	26.8	....	....	19,603	4.7	220,023	52.9	415,703	100.0
April	15,302	4.1	50,261	13.6	112,920	30.6	....	....	27,334	7.4	163,873	44.3	369,690	100.0
May	4,819	1.1	96,102	22.5	189,774	44.5	....	....	79,224	18.6	56,982	13.3	426,901	100.0
June	720	.3	19,095	9.1	126,182	60.1	11,501	5.5	49,435	23.6	2,880	1.4	209,813	100.0
July-Aug.	....	....	3,165	23.0	2,597	18.8	1.120	8.1	6,511	47.3	384	2.8	13,777	100.0
Total	84,678	2.6	451,542	13.9	1,144,086	35.1	12,993	.4	473,874	14.5	1,092,745	33.5	3,259,918	100.0

COSTS OF MARKETING

FREIGHT, SELLING AND OTHER COSTS, EXCLUDING PRESERVATION

The season average costs of marketing Florida citrus fruit in each of the five markets, by route of shipment are given in Table 7. No cost for preservation is included here, as only those costs which do not vary with the method of preservation used are shown.

It should be kept in mind that all average costs in this study were based upon the number of boxes sold, which may have been less in case of breakage than the number shipped. Charges for freight and pre-cooling were based upon the number of boxes shipped.

The number of boxes sold includes oranges, grapefruit, tangerines, Temples, and a few other kinds, all converted to the equivalent number of standard full boxes.

Freight includes the regular transportation charge made by the railroad, motor truck, or steamship company, plus a few other minor charges when they occurred, such as emergency charge, switching charge, back haul, and dock labor.

The auction selling cost includes the amount paid the auction receiver plus the charge by the auction company for selling the fruit. Since these auction charges were based on a percentage of the sales price, there may have been some variation in the auction selling cost due to the effect of the method of preservation used on the keeping quality or condition of the fruit at the time of sale, but most of the variation was due to changing proportions of oranges, grapefruit and tangerines and the different grades of each, the auction price of which was different for each class of fruit. For this reason the auction selling cost has been shown as constant for all methods of preservation.

Other costs include a large number of incidental and unusual expenses which were not very important except in a few cases. Among these costs are government inspection, reconsigning, demurrage, cataloging, storage, drayage, repairing damaged boxes, and heater service in extreme weather. Storage, when used, was by far the largest of these charges, and was incurred only in rail shipments, mainly in 1930-31.

Cincinnati, because of its relative proximity, had the lowest total cost per box for all-rail shipments, excluding preservation, and Detroit had the highest of the five markets (Fig. 5).

TABLE 7.—SEASON AVERAGE COSTS PER BOX OF MARKETING FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES AT AUCTION IN FIVE MARKETS (PRESERVATION COSTS EXCLUDED).

	1930-31	1931-32	1932-33	3-season weighted average
Rail shipments				
New York:				
Number of boxes	931,997	681,893	353,605	1,967,495
Freight	$ 0.953	$ 0.891	$ 0.959	$ 0.933
Selling	.060	.061	.054	.060
Other costs*	.012	.007	.003	.008
Total	$ 1.025	$ 0.959	$ 1.016	$ 1.001
Chicago:				
Number of boxes	312,423	170,465	164,637	647,525
Freight	$ 1.002	$ 1.003	$ 1.010	$ 1.005
Selling	.060	.061	.050	.058
Other costs*	.009	.005	.003	.006
Total	$ 1.071	$ 1.069	$ 1.063	$ 1.069
Detroit:				
Number of boxes	131,724	76,347	91,571	299,642
Freight	$ 1.006	$ 1.021	$ 1.020	$ 1.014
Selling	.060	.059	.051	.057
Other costs*	.011	.003	.004	.007
Total	$ 1.077	$ 1.083	$ 1.075	$ 1.078
Cincinnati:				
Number of boxes	94,823	57,715	69,187	221,725
Freight	$ 0.870	$ 0.866	$ 0.867	$ 0.868
Selling	.063	.062	.055	.060
Other costs*	.012	.002	.003	.007
Total	$ 0.945	$ 0.930	$ 0.925	$ 0.935
Pittsburgh:				
Number of boxes	64,392	26,889	32,250	123,531
Freight	$ 0.975	$ 0.965	$ 0.989	$ 0.976
Selling	.042	.041	.033	.039
Other costs*	.018	.005	.003	.011
Total	$ 1.035	$ 1.011	$ 1.025	$ 1.026
Rail and water shipments				
New York:				
Number of boxes	7,954	7,260	117,414	132,628
Freight	$ 0.780	$ 0.805	$ 0.699	$ 0.710
Selling	.045	.044	.036	.037
Other costs*	.034	**	**	.002
Total	$ 0.859	$ 0.849	$ 0.735	$ 0.749
Motor truck and water shipments				
New York:				
Number of boxes	1,155	145,457	359,610	506,222
Freight	$ 0.695	$ 0.680	$ 0.661	$ 0.667
Selling	.035	.047	.038	.041
Other costs*	.007	.007	.003	.004
Total	$ 0.737	$ 0.734	$ 0.702	$ 0.712

*Other costs include storage, drayage, demurrage, reconsigning and government inspection.

**Less than one-tenth of one cent.

Rail and water rates and motor truck and water rates to New York were considerably lower than all-rail rates. The rate via water from Jacksonville to New York was 46 cents per standard full box and from Tampa to New York was 55 cents per box. A different rate was effective for other containers. The motor truck charge for hauling from packinghouse to port varied, depending upon the distance and the season, from about 15 to 30 cents per box to Jacksonville, and from about 6 to 12 cents per box to Tampa.

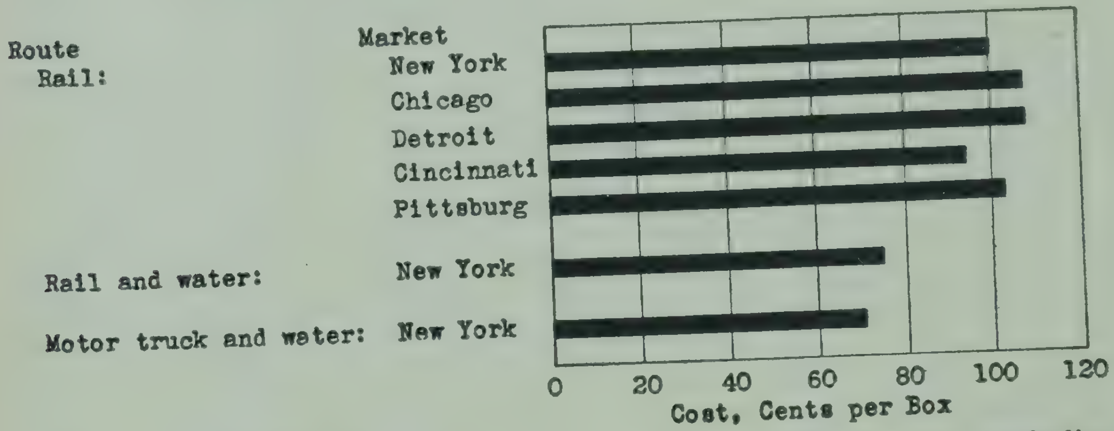

Fig. 5.—Average cost of freight, selling, and other costs (excluding preservation) for Florida citrus fruit from 31 packinghouses, sold at auction in five markets, by route of shipment (three seasons, 1930-31, 1931-32, and 1932-33).

PRESERVATION COSTS

The season average cost per box for pre-cooling and for refrigeration, according to the method of preservation used in transit, is shown in Table 8.

The most common charge for pre-cooling was 10 cents per box, though there was a variation of from 5 to 10 cents per box in the rate, depending upon the packinghouse, and the type of equipment used.

The cost for initial icing included the cost of the ice used and the charge made by the carrier for furnishing refrigerator cars. This latter charge was 20 percent of the cost of standard refrigeration to the market in question, except to New York in 1931-32 and 1932-33, when it was higher (Table 9). The most common charge per car for ice was $24.00. Some of the cars included under "Initially iced" in this study had extra ice added before reaching the market, and the charge for this was included in arriving at the average costs shown in Table 8.

The average charge for pre-cooling and initial icing combined was slightly less than the figure obtained by adding the aver-

TABLE 8.—SEASON AVERAGE COST PER BOX FOR PRESERVATION USED IN MARKETING FLORIDA CITRUS FRUIT FROM 31 PACKING-HOUSES AT AUCTION IN FIVE MARKETS.

Method of preservation	1930-31		1931-32		1932-33		Total or average	
	Number of boxes sold	Cost per box	Number of boxes sold	Cost per box	Number of boxes sold	Cost per box	Number of boxes sold	Cost per box
	Rail shipments							
New York:								
Pre-cooled	63,578	$0.097	3,852	$0.100	1,644	$0.087	69,074	$0.097
Initially iced	124,719	.103	114,290	.099	56,895	.100	295,904	.101
Pre-cooled and initially iced	338,475	.189	234,225	.170	144,457	.173	717,157	.179
Pre-cooled and standard refrigeration	11,901	.269	....	......	....	......	11,901	.269
Standard refrigeration	117,118	.170	100,734	.162	46,273	.163	264,125	.166
Standard ventilation	276,206	......	228,792	......	104,336	......	609,334	......
Chicago:								
Pre-cooled	7,726	$0.081	804	$0.100	....	......	8,530	$0.083
Initially iced	22,346	.110	22,946	.112	20,843	$0.108	66,140	.110
Pre-cooled and initially iced	106,162	.186	56,800	.174	78,803	.171	241,768	.178
Pre-cooled and standard refrigeration	720	.328	....	......	....	......	720	.328
Standard refrigeration	45,873	.226	20,816	.222	24,473	.215	91,162	.221
Standard ventilation	129,596	......	69,099	......	40,510	......	239,205	......
Detroit:								
Pre-cooled	2,172	$0.100	....	......	....	......	2,172	$0.100
Initially iced	8,098	.109	9,677	$0.113	18,578	$0.105	36,353	.108
Pre-cooled and initially iced	43,914	.196	15,864	.183	23,911	.185	83,689	.190
Pre-cooled and standard refrigeration	....	......	....	......	....	......	....	......
Standard refrigeration	28,170	.237	16,296	.234	16,884	.228	61,350	.233
Standard ventilation	49,370	......	34,510	......	32,198	......	116,078	......
Cincinnati:								
Pre-cooled	1,530	$0.078	384	$0.099	....	......	1,914	$0.083
Initially iced	12,976	.103	9,698	.103	13,020	.102	35,694	.104
Pre-cooled and initially iced	26,482	.186	16,261	.175	17,968	.134	60,711	.183
Pre-cooled and standard refrigeration	....	......	....	......	....	......	....	......
Standard refrigeration	16,007	.214	9,709	.188	13,947	.196	39,663	.201
Standard ventilation	37,828	......	21,663	......	24,252	......	83.743	......

TABLE 8.—SEASON AVERAGE COST PER BOX FOR PRESERVATION USED IN MARKETING FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES AT AUCTION IN FIVE MARKETS *(Concluded).*

Method of preservation	1930-31		1931-32		1932-33		Total or average	
	Number of boxes sold	Cost per box	Number of boxes sold	Cost per box	Number of boxes sold	Cost per box	Number of boxes sold	Cost per box
				Rail shipments (concluded)				
Pittsburgh:								
Pre-cooled	2,544	$0.089	444	$0.099	......	......	2,988	$0.090
Initially iced	8,081	.119	5,275	.116	4,095	$0.106	17,451	.115
Pre-cooled and initially iced	27,550	.190	3,992	.185	9,219	.198	40,761	.191
Pre-cooled and standard refrigeration	......	......	372	.304	......	......	372	.304
Standard refrigeration	6,484	.241	3,997	.233	7,093	.219	17,574	.230
Standard ventilation	19,733	......	12,809	......	11,843	......	44,385	......
				Rail and water shipments				
New York:								
Pre-cooled	5,110	$0.100	......	......	16,518	$0.076	21,628	$0.082
Initially iced	1,394	.092	......	......	......	......	1,394	.092
Pre-cooled and initially iced	......	......	752	$0.158	757	.164	1,509	.161
Pre-cooled and standard refrigeration	......	......	......	......	......	......	......	......
Standard refrigeration	......	......	......	......	......	......	......	......
Standard ventilation	1,450	......	6,508	......	100,139	......	108,097	......
				Motor truck and water shipments				
New York:								
Pre-cooled	......	......	303	$0.099	59,358	$0.101	59,661	$0.101
Initially iced	......	......	......	......	......	......	......	......
Pre-cooled and initially iced	......	......	......	......	......	......	......	......
Pre-cooled and standard refrigeration	......	......	......	......	......	......	......	......
Standard refrigeration	......	......	......	......	......	......	......	......
Standard ventilation	1,155	......	145,154	......	300,252	......	446,561	......

age pre-cooling cost per box to the average initial icing cost. Cars which were both pre-cooled and initially iced had fewer charges for extra ice in transit.

The average cost per box for standard refrigeration was higher than for pre-cooling and initial icing combined except to New York, to which point it was cheaper. This cost varied with the market (Table 9) and with the number of boxes per car, since the charge was a fixed amount per carload.

The highest cost per box was incurred for fruit that was pre-cooled and shipped standard refrigeration (Fig. 6). This method was little used, only one carload being shipped in other than the 1930-31 season.

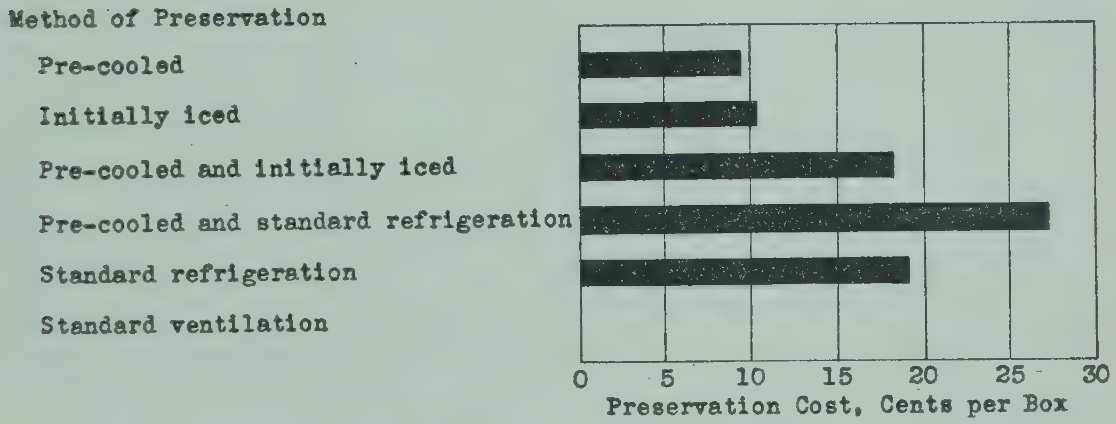

Fig. 6.—Average cost of preservation of Florida citrus fruit (rail shipments only) from 31 packinghouses to five markets, by method of preservation used, 1930-31, 1931-32, and 1932-33.

Fruit which was shipped standard ventilation bore no direct preservation costs.

TABLE 9.—COST PER CARLOAD FOR STANDARD REFRIGERATION AND FOR REFRIGERATOR CARS ONLY, FROM ALL PARTS OF THE FLORIDA CITRUS BELT TO FIVE MARKETS, 1930-31, 1931-32, AND 1932-33.

Market	Standard refrigeration	Refrigerator car only
New York	$60.00	$14.00*
Chicago	76.50	15.30
Detroit	81.00	16.20
Cincinnati	70.00	14.00
Pittsburgh	76.50	15.30

*$12.00 in 1930-31.

No costs have been included in Table 8 for brogdex treatment, borax, wax or other similar processes or substances which may have been used to increase the keeping quality or improve the appearance of the fruit.

TABLE 10.—THREE-SEASON AVERAGE COSTS PER BOX OF MARKETING FLORIDA CITRUS FRUIT FROM 31 PACKINGHOUSES AT AUCTION IN FIVE MARKETS, BY ROUTE AND BY METHOD OF PRESERVATION, 1930-31 TO 1932-33.

	Pre-cooled	Initially iced	Pre-cooled and initially iced	Pre-cooled and standard refrigeration	Standard refrigeration	Standard ventilation
			Rail shipments			
New York:						
Freight, selling, and other costs*	$1.001	$1.001	$1.001	$1.001	$1.001	$1.001
Preservation cost**	.097	.101	.179	.269	.166	....
Total	$1.098	$1.102	$1.180	$1.270	$1.167	$1.001
Chicago:						
Freight, selling, and other costs	$1.069	$1.069	$1.069	$1.069	$1.069	$1.069
Preservation cost	.083	.110	.178	.328	.221	....
Total	$1.152	$1.179	$1.247	$1.397	$1.290	$1.069
Detroit:						
Freight, selling, and other costs	$1.078	$1.078	$1.078	....	$1.078	$1.078
Preservation cost	.100	.108	.190	....	.233	....
Total	$1.178	$1.186	$1.268	....	$1.311	$1.078
Cincinnati:						
Freight, selling, and other costs	$0.935	$0.935	$0.935	....	$0.935	$0.935
Preservation cost	.083	.104	.183	....	.201	....
Total	$1.018	$1.039	$1.118	....	$1.136	$0.935
Pittsburgh:						
Freight, selling, and other costs	$1.026	$1.026	$1.026	$1.026	$1.026	$1.026
Preservation cost	.090	.115	.191	.304	.230	....
Total	$1.116	$1.141	$1.217	$1.330	$1.256	$1.026
			Rail and water shipments			
New York:						
Freight, selling, and other costs	$0.749	$0.749	$0.749	....	....	$0.749
Preservation cost	.082	.092	.161	....	....	....
Total	$0.831	$0.841	$0.910	....	....	$0.749
			Motor truck and water shipments			
New York:						
Freight, selling, and other costs	$0.712	....	....	....	....	$0.712
Preservation cost	.101	....	....	....	....	....
Total	$0.813	....	....	....	....	$0.712

*See Table 7.
**From Table 8.

TOTAL COSTS, ORIGIN TO MARKET

In Table 10 the preservation costs have been added to the costs of freight, auction selling, and other costs to obtain the total cost per box, by method of preservation used, from the packinghouse to the market. The average costs per box for freight, auction selling, and costs other than preservation are based on the total number of boxes sold in each market which were shipped by all methods of preservation, whereas the preservation cost is the average for the fruit sold in each market which was treated in a given manner.

AUCTION PRICES, BY METHOD OF PRESERVATION USED

To show, if possible, the methods of preservation which might be most economically used by Florida citrus shippers, the auction sales of the 31 packinghouses in each of the five markets were sorted by variety and grade of fruit and by method of preservation used, and compared monthly on the basis of the auction price received. This summary appears in Tables 11 and 12.

For the sake of brevity, only grade 1 oranges and grapefruit which were shipped by rail and sold in New York or Chicago are shown, although other varieties, grades, markets and routes were studied.

The auction prices are weighted averages. All sizes were included without sorting, as it was believed that about normal size distribution would be represented in each method of preservation.

Price comparisons are made monthly. This seemed to be the shortest period that could be used, because of the volume of fruit included, since a shorter period would give an inadequate sample for comparisons. However, a month is considered to be a rather long time for a price comparison, since fluctuations of the auction price within a month might offset, or emphasize, the advantage or disadvantage in price resulting from the method of preservation used, unless each method represented had an even distribution of shipments throughout the month.

Perhaps the greatest weakness lies in not knowing the condition of the fruit or state of preservation when it reached the auction for sale. It was found that fruit shipped standard ventilation (i. e., no refrigeration) frequently brought a higher price than that on which were used some methods of direct preservation and sometimes brought the highest average price

TABLE 11.—FLORIDA ORANGES: MONTHLY AVERAGE AUCTION PRICES PER BOX OF GRADE 1 IN NEW YORK AND CHICAGO, BY METHOD OF PRESERVATION USED.
(Rail Shipments Only)

Month sold	New York											
	Pineapple											
	Pre-cooled		Initially iced		Pre-cooled and initially iced		Pre-cooled and standard refrigeration		Standard refrigeration		Standard ventilation	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
1930-31												
September-October	....	......	....	......	....	......	....	......	257	$4.16	....	......
November	360	$3.53	179	$3.16	1,559	$4.04	....	......	3,667	3.95	692	$3.52
December	529	3.82	688	3.38	9,675	3.35	....	......	2,607	3.69	1,071	4.05
January	3,904	3.31	2,903	3.41	5,049	3.18	....	......	479	3.35	10,649	3.30
February	3,315	3.72	2,547	3.58	3,119	3.34	....	......	969	4.20	7,686	3.37
March	2,623	4.00	4,787	4.11	4,567	4.09	....	......	....	......	1,470	3.90
April	....	......	142	4.04	891	3.90	....	......	....	......	20	3.90
May	....	......	10	3.40	....	......	....	......	....	......	....	......
1931-32												
November	167	$3.53	858	$3.96	139	$3.22	....	......	235	$3.82	503	$3.44
December	....	......	4,893	3.46	3,540	3.63	....	......	2,013	3.76	1,745	3.68
January	....	......	4,406	3.49	5,072	3.29	....	......	5,074	3.53	4,935	3.50
February	....	......	3,141	3.81	8,104	3.75	....	......	5,696	3.68	3,322	3.63
March	....	......	2,584	4.10	1,383	3.86	....	......	1,564	3.76	648	4.03
April	....	......	....	......	29	3.69	....	......	....	......	46	4.02
1932-33												
November	....	......	89	$3.73	1,541	$3.54	....	......	40	$4.38	819	$4.28
December	....	......	4,260	2.94	9,205	3.32	....	......	2,155	3.38	3,718	2.93
January	....	......	2,930	3.25	5,660	3.46	....	......	2,320	3.68	4,721	3.06
February	....	......	3,019	3.04	3,977	2.86	....	......	1,146	3.35	2,156	2.61
March	....	......	1,397	2.93	6,265	3.12	....	......	1,442	2.89	52	2.62
April	....	......	....	......	2,820	2.78	....	......	....	......	....	......
May	....	......	....	......	44	2.00	....	......	....	......	....	......

TABLE 11.—FLORIDA ORANGES: MONTHLY AVERAGE AUCTION PRICES PER BOX OF GRADE 1 IN NEW YORK AND CHICAGO, BY METHOD OF PRESERVATION USED *(Continued)*.
(Rail Shipments Only)

Month sold	New York											
	Valencia											
	Pre-cooled		Initially iced		Pre-cooled and initially iced		Pre-cooled and standard refrigeration		Standard refrigeration		Standard ventilation	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
1930-31												
February	47	$3.32	336	$5.01	....	.....	....	.....	26	$3.38	430	$3.06
March	8,244	3.75	1,035	3.35	1,979	$3.88	....	.....	360	4.10	13,117	3.77
April	3,110	3.86	4,920	4.13	3,424	4.06	....	.....	4,463	3.98	15,988	3.92
May	360	4.30	9,271	3.85	24,958	3.87	....	.....	5,237	4.07	10,939	4.16
June	....	.....	5,233	4.27	13,919	4.43	4,226	$4.36	4,903	4.42	1,861	4.00
July-August	....	.....	727	4.30	....	.....	....	.....	255	4.83	735	3.97
1931-32												
February	....	.....	....	.....	114	$3.07	....	.....	....	.....	215	$3.73
March	....	.....	4,439	$4.02	3,918	3.84	....	.....	1,732	$4.02	18,999	4.12
April	888	$3.75	4,024	3.87	11,463	3.92	....	.....	1,091	4.02	14,580	3.97
May	....	.....	9,992	3.67	17,503	3.84	....	.....	4,089	4.18	4,643	3.72
June	....	.....	....	.....	18,584	3.71	....	.....	961	4.42	....	.....
1932-33												
February	....	.....	39	$2.56	344	$3.19	....	.....	119	$2.72	1,418	$3.00
March	....	.....	2,565	2.88	3,535	2.85	....	.....	1,945	2.99	338	2.88
April	363	$2.48	2,780	2.48	7,273	2.62	....	.....	1,162	2.71	324	2.08
May	....	.....	....	.....	903	3.06	....	.....	867	3.14	....	.....
June	....	.....	....	.....	....	.....	....	.....	139	3.00	....	.....

TABLE 11.—FLORIDA ORANGES: MONTHLY AVERAGE AUCTION PRICES PER BOX OF GRADE 1 IN NEW YORK AND CHICAGO, BY METHOD OF PRESERVATION USED (*Continued*).
(Rail Shipments Only)

Month sold	Chicago											
	Pineapple											
	Pre-cooled		Initially iced		Pre-cooled and initially iced		Pre-cooled and standard refrigeration		Standard refrigeration		Standard ventilation	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
	1930-31											
November	360	$3.78	......	......	2,212	$3.67	......	......	......	......	750	$2.76
December	......	......	109	$2.83	1,877	3.20	......	......	460	$2.63	802	3.40
January	1,080	2.96	386	3.16	1,229	3.23	......	......	185	2.76	1,317	2.96
February	......	......	......	......	1,353	3.24	......	......	......	......	3,605	3.21
March	......	......	178	3.89	757	3.85	......	......	......	......	1,471	3.99
April	......	......	......	......	......	......	......	......	......	......	74	3.66
	1931-32											
November	......	......	......	......	67	$3.04	......	......	......	......	336	$3.90
December	......	......	171	$2.71	920	3.07	......	......	22	$3.32	1,860	3.20
January	......	......	75	3.24	636	3.43	......	......	1,769	3.42	317	2.83
February	......	......	435	3.46	806	3.32	......	......	1,135	3.31	......	......
	1932-33											
December	......	......	814	$3.05	1,077	$2.92	......	......	1,620	$3.08	247	$3.12
January	......	......	151	3.23	288	1.80	......	......	564	3.04	......	......
February	......	......	259	3.22	234	2.73	......	......	53	2.70	261	2.45
March	......	......	581	2.65	156	2.83	......	......	775	2.54	......	......
April	......	......	......	......	487	2.62	......	......	336	2.33	......	......

TABLE 11.—FLORIDA ORANGES: MONTHLY AVERAGE AUCTION PRICES PER BOX OF GRADE 1 IN NEW YORK AND CHICAGO, BY METHOD OF PRESERVATION USED *(Concluded)*.
(Rail Shipments Only)

Month sold	Chicago											
	Valencia											
	Pre-cooled		Initially iced		Pre-cooled and initially iced		Pre-cooled and standard refrigeration		Standard refrigeration		Standard ventilation	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
					1930-31							
March	....	......	210	$3.63	397	$3.66	....	......	....	......	4,323	$3.88
April	....	......	680	4.04	453	4.06	....	......	....	......	3,559	3.82
May	....	......	1,343	3.69	6,647	3.71	....	......	4,239	$4.04	1,764	3.79
June	....	......	360	3.76	2,263	3.97	....	......	2,914	4.14	....	......
					1931-32							
March	....	......	....	......	1,212	$3.52	....	......	....	......	1.238	$3.73
April	....	......	1,079	$4.01	1,643	3.84	....	......	....	......	1,921	3.81
May	....	......	874	3.81	3,085	3.64	....	......	740	$3.60	530	3.85
June	....	......	....	......	444	3.30	....	......	....	......	....	......
					1932-33							
March	....	......	....	......	....	......	....	......	121	$2.79	57	$3.42
April	....	......	98	$2.95	274	$2.64	....	......	590	2.88	237	2 58
May	....	......	1,733	2.59	391	2.37	....	......	131	2.94	240	2.49
June	....	......	94	3.12	700	3.05	....	......	189	2.93	....	......
July-August	....	......	....	......	37	3.38	....	......	....	......	....	......

TABLE 12.—FLORIDA GRAPEFRUIT: MONTHLY AVERAGE AUCTION PRICES PER BOX OF GRADE 1 IN NEW YORK AND IN CHICAGO, BY METHOD OF PRESERVATION USED.
(Rail Shipments Only)

Month sold	New York											
	Marsh Seedless											
	Pre-cooled		Initially iced		Pre-cooled and initially iced		Pre-cooled and standard refrigeration		Standard refrigeration		Standard ventilation	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
					1930-31							
December	....	......	....	......	129	$3.50	....	......	....	......	388	$5.13
January	....	......	....	......	93	4.24	....	......	....	......	941	4.40
February	....	......	....	......	10	3.20	....	......	....	......	4,718	3.15
March	249	$2.78	....	......	....	......	....	......	....	......	6,404	3.65
April	1,468	3.01	5,383	$3.96	328	3.35	....	......	875	$4.22	6,681	3.69
May	1,526	2.71	9,119	3.44	4,738	2.89	....	......	5,914	3.62	508	2.81
June	....	......	677	2.24	6,400	2.20	1,293	$2.61	4,750	3.15	....	......
July-August	....	......	174	.48	372	.71	508	2.30	360	1.89	372	.50
					1931-32							
September-October	....	......	....	......	23	$4.09	....	......	....	......	....	......
November	....	......	....	......	....	......	....	......	....	......	....	......
December	....	......	....	......	....	......	....	......	....	......	1,641	$3.21
January	....	......	81	$3.25	51	2.96	....	......	....	......	543	3.39
February	....	......	247	2.67	159	2.50	....	......	325	$2.80	8,020	2.66
March	....	......	232	2.33	382	3.07	....	......	524	3.15	9,158	3.14
April	....	......	1,443	4.08	2,835	3.26	....	......	206	3.45	6,980	3.52
May	....	......	2,006	3.93	4,894	3.74	....	......	3,468	4.46	1,657	3.40
June	....	......	....	......	3,088	4.46	....	......	1,314	4.78	....	......
					1932-33							
November	....	......	428	$4.75	929	$4.07	....	......	....	......	104	$4.31
December	....	......	220	3.96	335	3.59	....	......	....	......	2,709	3.95
January	....	......	112	4.39	185	3.81	....	......	....	......	1,253	3.89
February	....	......	....	......	187	4.30	....	......	101	$4.10	2,207	3.90
March	....	......	729	3.44	468	3.33	....	......	86	3.29	5,141	3.38
April	1	$2.00	1,009	2.66	1,545	3.09	....	......	....	......	4,872	3.74
May	41	2.85	1,043	3.32	507	2.50	....	......	113	4.63	431	2.53
		......	....	......	345	2.00	....	......	....	......	....	......

TABLE 12. FLORIDA GRAPEFRUIT: MONTHLY AVERAGE AUCTION
CHICAGO, BY METHOD OF PRESERVATION USED *(Continued).*
(Rail Shipments Only)

Month sold	New York											
	Other varieties											
	Pre-cooled		Initially iced		Pre-cooled and initially iced		Pre-cooled and standard refrigeration		Standard refrigeration		Standard ventilation	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
1930-31												
September-October	....	......	....	......	8,652	$3.90	....	......	11,829	$4.38	1,464	$3.36
November	....	......	2,513	$3.58	5,821	3.21	....	......	11,026	3.81	7,341	3.36
December	3,696	$2.86	3,354	3.36	3,611	3.01	....	......	1,039	3.48	12,534	3.35
January	1,232	2.93	120	2.54	1,503	2.68	....	......	....	......	26,102	3.09
February	....	......	300	2.92	253	2.61	....	......	142	3.63	22,389	2.92
March	3,436	2.58	344	2.81	1,072	2.76	....	......	....	......	18,524	2.87
April	2,655	2.56	1,153	3.10	6,769	2.88	....	......	173	3.07	8,366	3.03
May	641	1.92	3,822	2.20	6,301	2.38	....	......	4,815	2.61	887	2.51
June	....	......	724	1.91	4,749	1.28	575	$2.93	1,803	2.93	718	2.19
July-August	....	......	198	.66	....	......	13	2.69	....	......	....	......
1931-32												
September-October	....	......	4,428	$3.03	1,477	$2.96	....	......	4,830	$3.83	732	$2.54
November	....	......	8,197	3.50	2,029	2.81	....	......	1,014	2.98	9,266	2.82
December	....	......	1,661	3.03	918	2.37	....	......	420	3.09	18,135	2.66
January	....	......	846	2.29	784	2.49	....	......	889	2.58	14,378	2.61
February	....	......	307	2.05	481	2.19	....	......	685	2.24	12,351	2.50
March	444	$2.86	553	2.79	2,767	2.64	....	......	76	3.00	7,711	2.69
April	....	......	264	3.61	2,016	2.93	....	......	....	......	1,293	3.04
May	....	......	52	3.04	91	3.49	....	......	93	3.80	....	......
June	....	......	94	4.97	312	4.16	....	......	....	......	....	......
July-August	....	......	304	5.61	....	......	....	......	121	2.36	....	......
1932-33												
September-October	....	......	1,245	$3.63	....	......	....	......	4,077	$4.07	....	......
November	....	......	2,075	3.86	3,283	$3.24	....	......	....	......	4,199	$3.60
December	....	......	408	2.55	1,465	2.90	....	......	3,116	3.78	12,989	2.85
January	....	......	258	3.14	968	2.87	....	......	53	3.28	4,784	3.05
February	....	......	315	2.86	504	2.99	....	......	....	......	3,817	3.19
March	....	......	561	2.78	1,692	2.56	....	......	64	2.84	2,653	2.58
April	....	......	16	1.62	995	2.62	....	......	....	......	1,067	2.55
May	....	......	....	......	....	......	....	......	....	......	....	......
June	....	......	....	......	....	......	....	......	138	3.77	....	......
July-August	....	......	....	......	....	......	....	......	....	......	305	1.50

TABLE 12.—FLORIDA GRAPEFRUIT: MONTHLY AVERAGE AUCTION PRICES PER BOX OF GRADE 1 IN NEW YORK AND IN CHICAGO, BY METHOD OF PRESERVATION USED *(Continued).*
(Rail Shipments Only)

Month sold	Chicago											
	Marsh Seedless											
	Pre-cooled		Initially iced		Pre-cooled and initially iced		Pre-cooled and standard refrigeration		Standard refrigeration		Standard ventilation	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
					1930-31							
November	....	......	....	......	26	$3.77	....	......	....	......	....	......
December	....	......	....	......	....	......	....	......	22	$2.23	....	......
January	....	......	....	......	245	3.18	....	......	....	......	1,593	$3.48
February	....	......	....	......	126	3.11	....	......	....	......	1,075	2.98
March	360	$2.73	....	......	....	......	....	......	....	......	1,175	2.99
April	....	......	25	$3.04	795	2.93	....	......	744	3.61	3,289	2.65
May	84	2.56	1,673	2.52	2,258	2.89	....	......	1,740	3.03	167	1.10
June	....	......	356	2.50	2,884	2.36	....	......	1,522	2.62	....	......
July-August	....	......	....	......	....	......	....	......	224	1.48	....	......
					1931-32							
November	....	......	....	......	106	$3.39	....	......	....	......	48	$3.35
December	....	......	....	......	3	3.00	....	......	....	......	125	2.65
January	....	......	....	......	129	2.66	....	......	....	......	466	2.51
February	....	......	....	......	156	2.30	....	......	732	$2.34	1,186	2.35
March	82	$2.28	75	$2.27	....	......	....	......	....	......	1,062	2.55
April	....	......	337	3.39	1,764	3.09	....	......	261	3.75	3,203	2.95
May	....	......	....	......	2,670	4.17	....	......	477	4.11	845	3.98
June	....	......	....	......	108	3.86	....	......	....	......	....	......
					1932-33							
September-October	....	......	....	......	16	$3.50	....	......	....	......	....	......
November	....	......	....	......	....	......	....	......	....	......	....	......
December	....	......	....	......	....	......	....	......	....	......	....	......
January	....	......	....	......	....	......	....	......	....	......	....	......
February	....	......	....	......	....	......	....	......	....	......	689	$3.19
March	....	......	....	......	....	......	....	......	....	......	1,808	3.26
April	....	......	390	$3.12	183	2.03	....	......	....	......	894	2.28
May	....	......	464	3.28	579	1.87	....	......	163	$3.28	1,120	2.59
June	....	......	85	2.12	1,260	2.31	....	......	....	......	....	......

TABLE 12.—FLORIDA GRAPEFRUIT: MONTHLY AVERAGE AUCTION PRICES PER BOX OF GRADE 1 IN NEW YORK AND IN CHICAGO, BY METHOD OF PRESERVATION USED (*Concluded*).
(Rail Shipments Only)

Month sold	Chicago											
	Other varieties											
	Pre-cooled		Initially iced		Pre-cooled and initially iced		Pre-cooled and standard refrigeration		Standard refrigeration		Standard ventilation	
	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price	Boxes	Price
					1930-31							
September-October	....	......	....	......	4,098	$3.80	....	......	2,180	$3.68	508	$2.48
November	240	$2.84	526	$2.74	4,584	3.20	....	......	2,049	3.01	435	2.86
December	....	......	251	3.45	2,557	2.81	....	......	832	2.84	5,063	2.97
January	360	2.74	30	3.00	2,620	2.73	....	......	....	......	10,898	2.88
February	....	......	....	......	360	2.56	....	......	....	......	6,539	2.80
March	....	......	135	2.48	779	2.79	....	......	....	......	7,968	2.58
April	360	3.00	323	2.83	544	2.37	....	......	207	3.04	1,735	2.63
May	276	2.05	507	2.25	1,078	2.61	....	......	1,007	2.57	224	1.00
June	....	......	....	......	240	2.20	....	......	....	......	....	......
					1931-32							
September-October	....	......	2,006	$2.67	190	$3.04	....	......	3,465	$3.50	....	......
November	....	......	1,157	2.74	887	2.68	....	......	372	2.59	4,464	$2.85
December	....	......	236	2.80	343	2.64	....	......	46	2.61	3,486	2.47
January	....	......	330	2.15	513	2.25	....	......	....	......	5,105	2.29
February	....	......	....	......	372	2.17	....	......	86	2.34	2,001	2.14
March	....	......	....	......	....	......	....	......	....	......	2,508	2.10
April	....	......	181	3.48	835	2.93	....	......	....	......	55	3.24
May	....	......	586	3.91	204	2.65	....	......	....	......	....	......
June	....	......	....	......	....	......	....	......	....	......	....	......
					1932-33							
September-October	....	......	....	......	1,131	$3.77	....	......	1,277	$3.75	....	......
November	....	......	445	$3.40	927	3.26	....	......	441	3.01	1,247	$3.13
December	....	......	175	2.54	232	3.57	....	......	43	3.00	931	3.13
January	....	......	113	3.12	....	......	....	......	....	......	2,014	2.66
February	....	......	36	2.67	....	......	....	......	....	......	1,990	2.50
March	....	......	36	2.81	11	2.18	....	......	....	......	928	2.15
April	....	......	....	......	45	2.58	....	......	....	......	43	1.44
May	....	......	....	......	206	1.93	....	......	80	3.25	....	......
June	....	......	....	......	....	......	....	......	23	2.39	....	......
July-August	....	......	....	......	....	......	....	......	256	2.54	....	......

of any method for the month. Whether this fruit was better than average at the time of shipment and the shipper, believing it would carry through satisfactorily without ice, omitted refrigeration for that reason, is not known.

It should be pointed out again that there was a seasonal relationship in the method of preservation used (Table 6). Standard ventilation was used extensively in the cooler months, and standard refrigeration was more generally used in the hotter months. Pre-cooling and initial icing combined were also used a great deal in the hot months, but this was a rather important method throughout the season.

There was no relationship between the method of preservation used and the auction price received for the fruit when compared monthly. This assertion does not necessarily mean that no pre-cooling or refrigeration should ever be used. The condition of the fruit at the time of placing it on the auction is unquestionably important, and if the fruit or weather conditions are such at the time of shipment as to make refrigeration necessary for fruit preservation it will undoubtedly be economical to use it. However, the cost for standard refrigeration or pre-cooling and initial icing combined is considerable, and the selling price will have to be raised more than this amount to make such preservation advantageous.

If the costs of preservation be deducted from the auction prices to give net price figures directly comparable with auction prices of fruit shipped by standard ventilation, the advantage of any method of refrigeration over standard ventilation was less pronounced.

SUMMARY

Shipments of packed citrus fruit from 31 Florida packinghouses to five auction markets by rail, rail and water, and motor truck and water for the three seasons, 1930-31, 1931-32, and 1932-33, are included in this study.

New York was the most important of the five auctions included, receiving approximately twice as much fruit during the three seasons as the four other markets combined—viz., Chicago, Detroit, Cincinnati, and Pittsburgh (Table 1 and Fig. 1).

Chicago, Detroit, Cincinnati, and Pittsburgh received fruit from the 31 packinghouses by rail only. In 1930-31, 99 percent of the shipments to New York went all-rail; but in 1932-33 water routes accounted for 57.4 percent of the New York receipts from the 31 packinghouses (Table 2 and Fig. 2).

The most common methods of preservation used in rail shipments to the five markets were pre-cooling and initial icing combined, and standard ventilation (or no refrigeration). These two methods together accounted for 68.6 percent of the rail shipments by all methods during the three seasons (Table 4 and Fig. 4).

Standard ventilation was used mainly in the cooler months, November through April, while in the hotter months there was an increased use of standard refrigeration, and of pre-cooling and initial icing combined. The last named method was fairly important the year round, based on the percentage of the total shipments each month by that method.

The three-season weighted average cost per box for freight, selling and other costs, excluding preservation, for fruit shipped by rail to New York was $1.00; to Chicago, $1.07; to Detroit, $1.08; to Cincinnati, $0.94; and to Pittsburgh, $1.03. Rail and water shipments to New York averaged 75 cents per box, and motor truck and water shipments to New York averaged 71 cents per box (Table 7 and Fig. 5).

Average preservation costs to the five markets for the three seasons were as follows: For pre-cooling, 9.5 cents per box; initial icing, 10.3 cents; pre-cooling and initial icing combined, 18.1 cents; pre-cooling and standard refrigeration, 27.3 cents; and for standard refrigeration, 19.1 cents per box. Fruit shipped standard ventilation bore no direct charges for preservation (Fig. 6 and Table 8).

There was no relationship between the method of preservation used in marketing citrus fruit from the 31 Florida packinghouses and the auction price received when compared monthly (Tables 11 and 12). The condition of the fruit when it arrived for sale on the auction was not known; thus it was impossible to determine the relative efficiency of the various methods of refrigeration in preserving the fruit.

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UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
WILMON NEWELL, Director
GAINESVILLE, FLORIDA

SELECTING AND USING BEEF AND VEAL

W. G. KIRK AND A. L. SHEALY

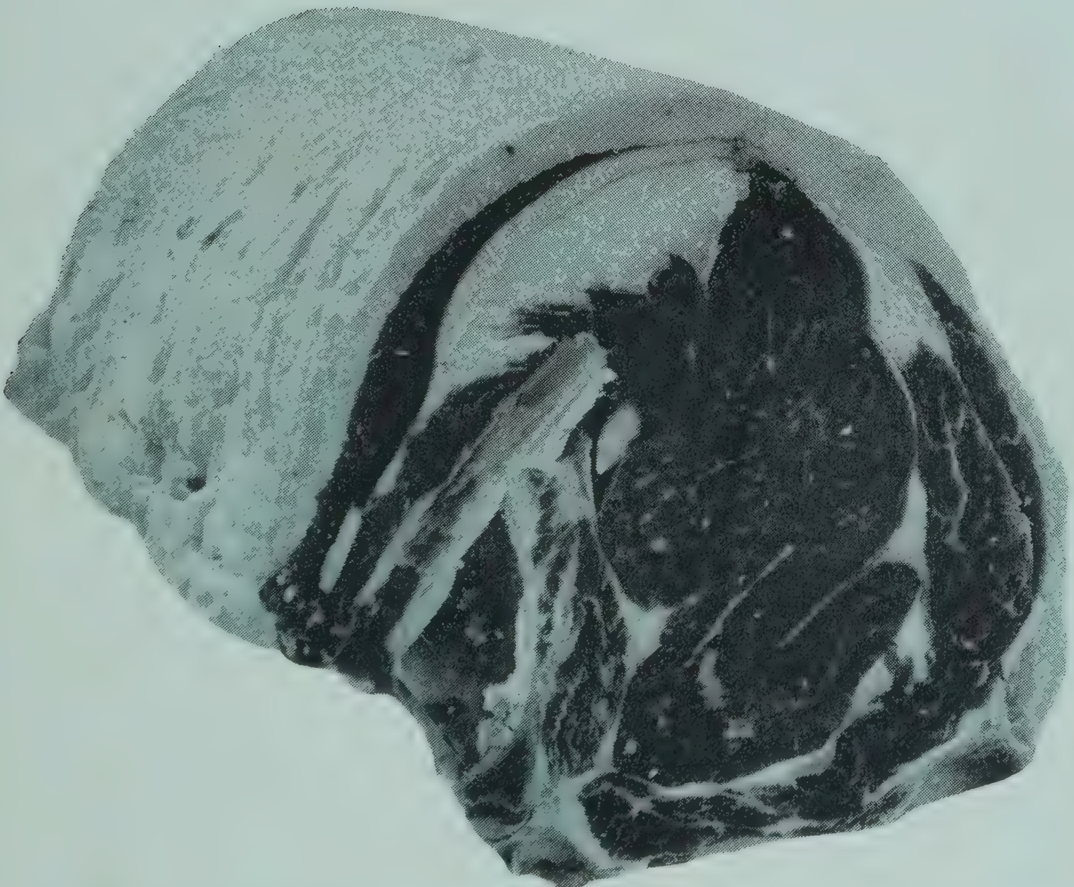

Fig. 1.—An attractive folded rib roast from the 9th and 10th rib section.

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SELECTING AND USING BEEF AND VEAL

W. G. Kirk and A. L. Shealy

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Meat is a nutritious and palatable food. The various elements found in it—protein, fat and minerals—are similar to those comprising the human body. Because of this it can be easily digested and utilized by the body for growth and maintenance. Vitamins B and G, which protect against deficiency diseases, particularly pellagra, are present in relatively large amounts. The extractives of meat give it flavor and make it one of the most palatable of all foods.

In purchasing most foods, the housewife knows what she wants. Especially is this true of staple articles, canned goods, fruits and vegetables. Canned goods are purchased largely by their brands or trade names, while the selection of fruits and vegetables is based upon their quality and freshness. However, meats, particularly beef and veal, usually are not selected on such a well established basis. How often is the expression heard, "Oh! just give me a steak" or "cut off a roast". The purchaser realizes that there are many different kinds of steaks and roasts, but comparatively few purchasers of beef and veal are able to recognize the cuts of meat they desire.

The objects in offering this bulletin are: (1) to provide purchasers with a means of identifying the various cuts of beef and veal, (2) to give a guide to the selection of meat from a quality standpoint, (3) to present methods of preservation which will enable anyone to have beef available for use at any season of the year, and (4) to outline some of the standard methods used in the preparation of meat.

SELECTION OF BEEF AND VEAL

FACTORS WHICH INFLUENCE THE GRADE OF BEEF

The term "beef" as generally used is rather comprehensive. It includes the meat from all classes of cattle except that which is obtained from vealers and calves. Quite often the terms "veal" and "calf" are used interchangeably to designate the meat from cattle usually not more than one year old. Veal, however, is the flesh of calves not under three weeks and not over 12 weeks of age at time of slaughter. Calf carcasses are from animals which have passed beyond the veal stage (from three to 12 months) but have not taken on beef characteristics. The meat from calves possesses some of the characteristics of both veal and beef. Baby beef is procured from animals having a high degree of finish which are marketed when 14 to 18 months old. The meat from all other cattle is known as beef.

Three factors used to determine the grade of a beef carcass are: (1) conformation or form; (2) amount and distribution of fat, commonly known as finish; and (3) quality.

Conformation.—The term conformation refers to the general form and outline of the carcass and is determined by the size and shape of the bones, thickness of the muscles, and amount and distribution of the fat. Conformation indicates the proportion of lean, fat and bone in the carcass as well as the relation between the high quality and low quality cuts. A high grade carcass has short shanks and neck, well developed round, heavily fleshed loin and ribs, with not too large a proportion of plate and chuck. In contrast, a low grade carcass usually has long shanks and neck, prominent shoulder and hip bones, and thinly fleshed round, loin and ribs.

Finish.—Finish is the amount, character and distribution of external and internal fat throughout the carcass. A well finished or high grade beef carcass has an even covering of brittle, flaky, creamy white fat over the chuck, ribs, loin and round with a smaller amount on the shanks, neck and plate. There are large but not excessive amounts of fat around the kidneys. When such a carcass is cut, relatively heavy deposits of fat are found between the larger muscles and a liberal distribution of fat occurs between the muscle bundles. This last condition, an intermixture of lean and fat, is known as "marbling".

Fat is important because it adds to the attractiveness of the carcass or cut. Its greatest significance, however, lies in the fact that fat makes the meat more palatable and increases the degree of tenderness. A low grade carcass is deficient in external and internal fat and there is seldom any sign of "marbling". The fat that is present is distributed unevenly throughout the carcass and may be soft in character.

The degree of finish influences the keeping quality of beef. If the exterior of the carcass is well covered with fat the meat can be aged or ripened for several days. Aging increases the degree of tenderness and improves the quality and palatability of the meat. Beef with no fat covering cannot be aged or ripened.

Quality.—The term quality embodies all that has been mentioned previously concerning conformation and finish, and in addition refers to the degree of fineness in bones and flesh. Quality in meat is determined by the size, color and texture of the bones; color, firmness, and texture of the muscle fibers; amount of connective tissue present, and the distribution, color and texture of the fat. In good quality beef, the bones are relatively small and if from a young animal are red in color and porous in character on the cut surfaces. The lean is fine in texture, bright red in color, smooth and velvety in appearance and well marbled with creamy white, flaky fat. Poor quality beef contains a relatively large proportion of bone which is often white and flinty in character. The lean is coarse in texture, dark red in color, and has a relatively large quantity of connective tissue. Usually the carcass contains little fat which is not distributed uniformly.

GRADES OF BEEF CARCASSES

Most canned and packaged goods are sold under certain brands and when a particular brand is purchased, a definite standard product is obtained. More and more is this true in the wholesale and retail distribution of beef and veal. The United States Department of Agriculture and various meat packing companies have established certain grades for fresh beef and a uniform definite standard for each of these grades is gradually becoming recognized. The grades of beef set up by the United States Department of Agriculture from highest to lowest are: prime, choice, good, medium and plain. Each of the large meat packing concerns has grades that correspond with these. The retail merchant who purchases beef and veal slaughtered locally grades the meat in his mind somewhat similarly to the grades given above. The housewife may purchase meat by asking for a cut from a choice, good or medium carcass or wholesale cut. The price range is also from high to low, depending upon the grade of meat purchased.

Prime beef nearly approaches the ideal in conformation, finish and quality. It comes from steers or the choicest heifers. Only 1 to 2 percent of all cattle fall within this grade. The prime grade of meat is used almost entirely by restaurants and hotels catering to a fastidious trade.

Choice or second grade is the top grade sold in many of the best markets. Such beef is obtained from well fed steers and heifers that have excellent beef conformation. High quality roasts and steaks can be cut from this grade of meat.

The third or good grade of beef comes from grain-fed cattle showing less finish than the prime and choice grades, and from the highest grade of grass-fattened cattle. It carries a fair amount of exterior fat and a considerable quantity of interior fat and marbling.

The medium grade of carcass is from steers or heifers of slightly inferior conformation and finish. Meat of this grade may be well flavored and low in price, but will need longer cooking.

The plain grade is from animals of inferior beef conformation. The carcass lacks in thickness of fleshing throughout and there is little, if any, fat on the exterior or between the muscles. It comes from the low grade steers, heifers, and cows. Meat of this grade is used mostly for stew meat, ground beef (hamburger), mince meat, and for process meat.

FLAVOR IN MEAT

Flavor in meat is largely determined by the presence or absence of meat extractives and internal and external fat. As the animal matures, meat extractives increase in the muscles. Veal is tender because it comes from a young animal but for the same reason contains very little meat extractives and fat which renders it deficient in natural meat flavor. In contrast, meat from a mature animal lacks in tenderness because of the hardness of the muscle fibers and the amount of connective tissue present but has sufficient meat extractives to give a well flavored product. Beef from steers and heifers 16 to 30 months of age, of good conformation and carrying a moderate amount of finish, has sufficient meat extractives and fat to be well flavored and comparatively tender.

CUTTING OF MEAT

One object in cutting meat is to obtain pieces suitable in size for use in the home. There are several other factors, however, which are taken into account in dividing a side of beef or veal. One of the important things to consider is the muscle structure of the meat. Whenever possible the lean meat should be cut crosswise of the fibers. There are muscles going in various directions in the region of the large shoulder joint and the pelvic section. This makes it difficult to cut across all the muscles in these areas. The retail merchant separates the round and loin, heavily muscled parts, from the flank which is made up of thin muscles. The rib, a high quality cut, is separated from the navel, a low quality cut. In addition, meat is cut in such way that it will be attractive in appearance.

CUTS OF BEEF

A side of beef is divided into fore and hind quarters. The division usually is made between the 12th and 13th ribs which leaves one rib on the hindquarter. The quarters are divided further into wholesale cuts from which are obtained the retail pieces (Fig. 2).

The sides of beef and veal and cuts of these two meats shown on the following pages are from beef cattle raised at the Florida Agricultural Experiment Station. The meat was cut by the senior author and the pictures were made by Assistant Director Harold Mowry.

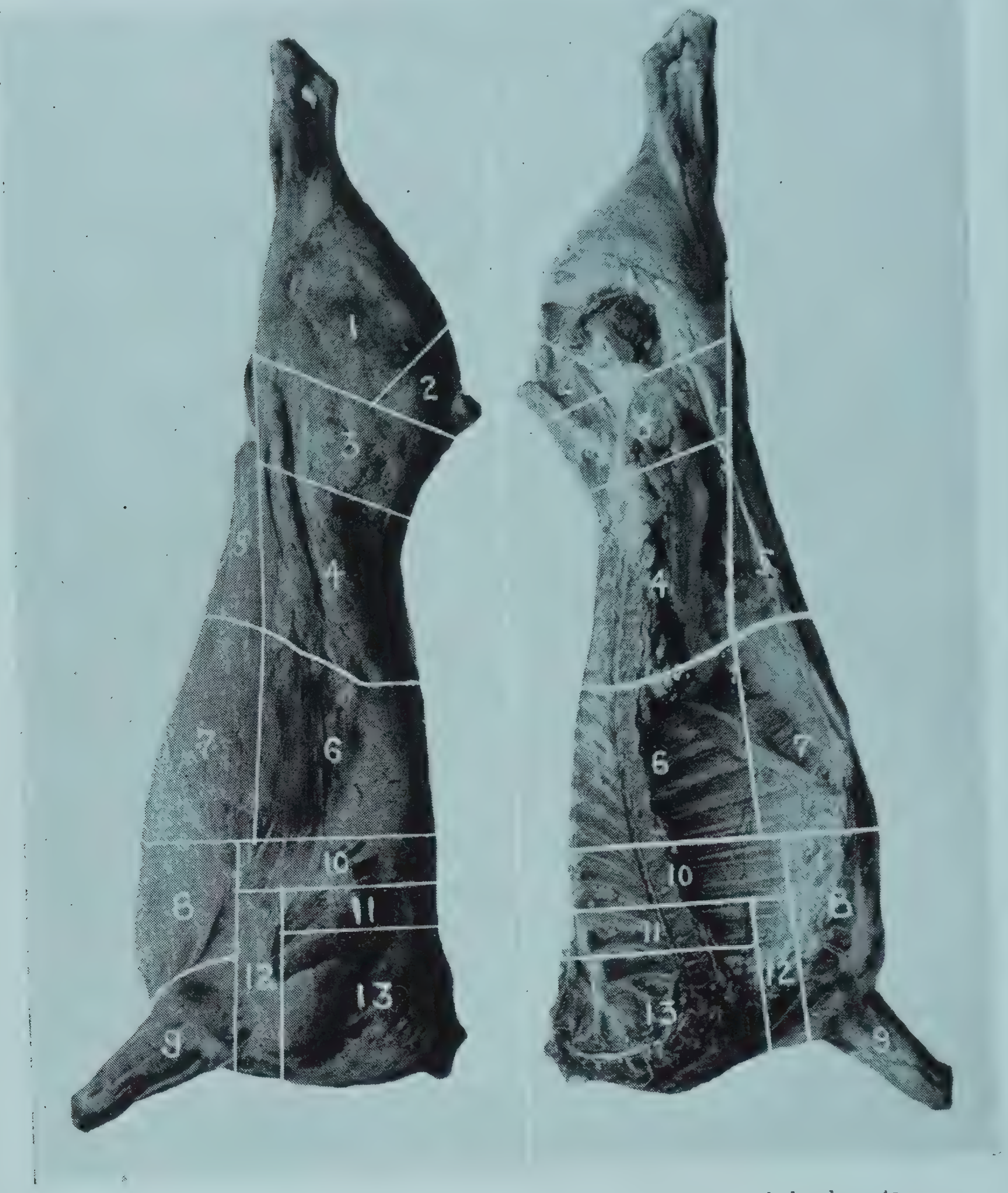

Fig. 2.—Side of beef, outside and inside views, showing wholesale cuts.

Side of Beef.—The following wholesale cuts are shown.

1. Round
2. Rump
3. Loin end
4. Short loin
5. Flank
6. Beef ribs
7. Navel ⎫ make up
8. Brisket ⎭ the plate
9. Fore shank
10. Chuck rib roast
11. Chuck roast
12. Round bone pot roast
13. Neck

According to United States Department of Agriculture standard grades the above side of beef would grade "good". Note the fullness of the round and loin and the compactness of the carcass. The fat is uniformly distributed over the loin, ribs, chuck and over the thicker part of the round. There is little fat, however, on the plate and lower part of the round.

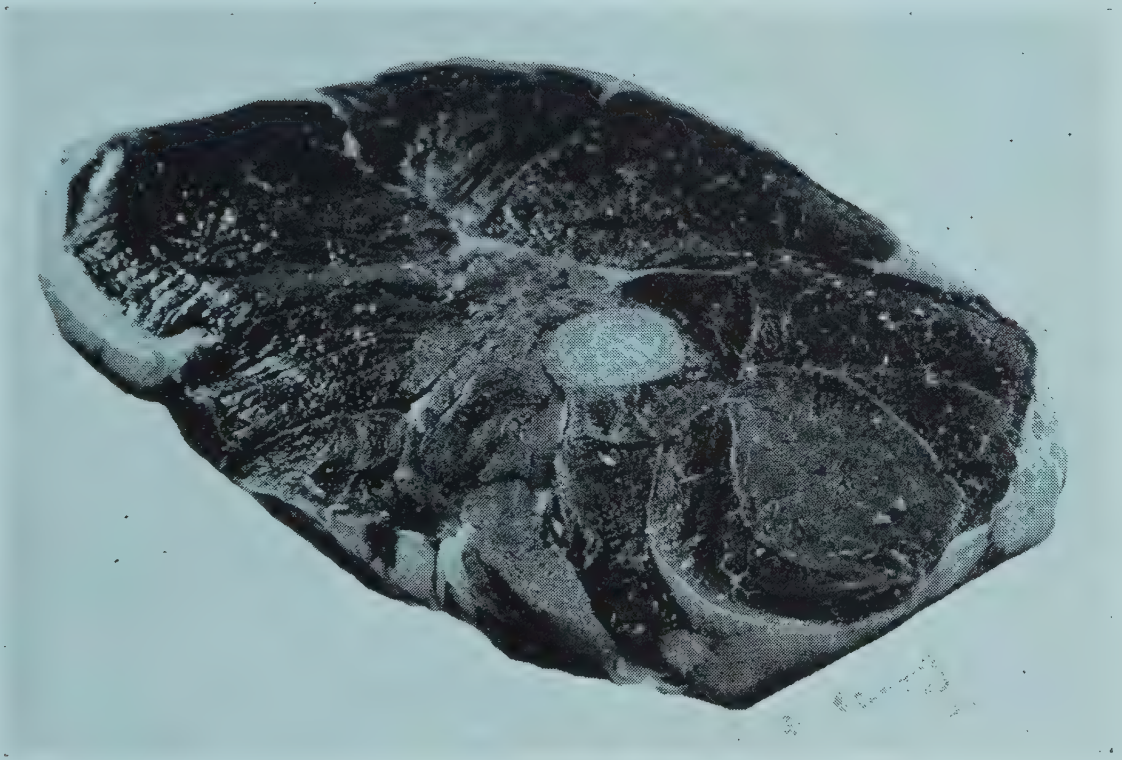

Fig. 3.—Round steak, the least expensive steak of the hindquarter.

Round Steak.—Round steak is oval in shape with a small round bone in the center. It consists of several large muscles but lacks in exterior and interior fat. The cut shown, however, has more fat throughout the lean tissue than is found generally in round steak. The steak above is from the center of the wholesale round which is higher in quality than steaks cut from either the loin or shank end. Round steak is the least expensive steak of the hindquarter. The shank end of the round contains a relatively small amount of lean meat and a large amount of bone and connective tissue. It is used as pot roast, stew or ground meat.

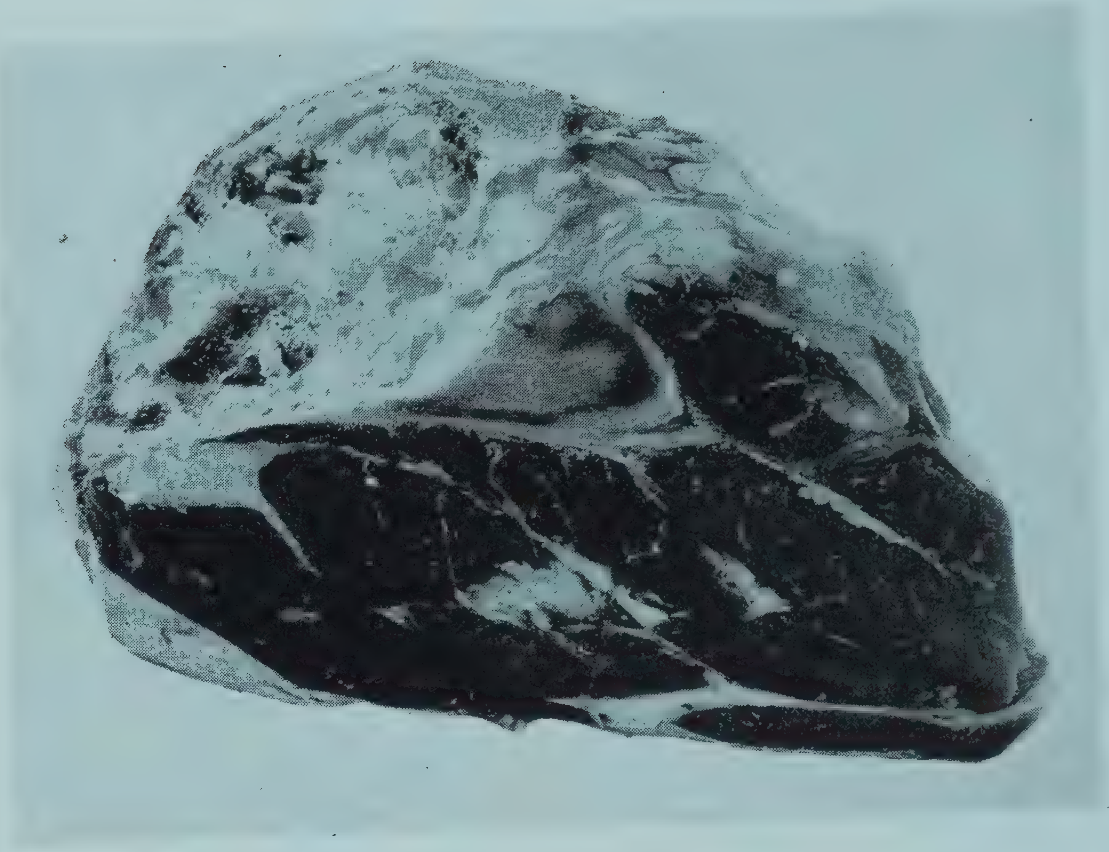

Fig. 4.—Rump roast.

Rump Roast.—The rump is a wedge-shaped piece of meat lying between the round and loin end (Fig. 2, No. 2). It has a moderate amount of fat and a relatively large portion of bone, as it contains the hip joint and part of the pelvic arch. This cut is suitable for roasting, and for this purpose it frequently is boned and rolled. The lean portion can be used as boneless steaks for broiling or pan frying.

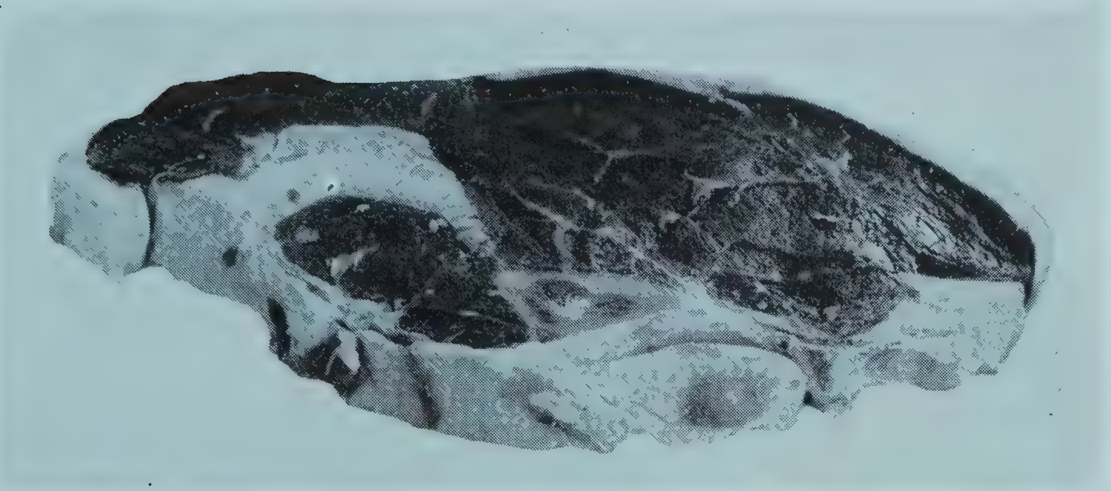

Fig. 5.—Round bone sirloin steak.

Round Bone Sirloin Steak.—Sirloin steaks are obtained from the wholesale loin end cut (Fig. 2, No. 3) and are characterized by being oblong in shape and containing sections of the backbone and hip bone. No two sirloin steaks are the same in muscle and bone because of the changing positions of these structures. The steaks procured from the loin end are considered more tender and to have a more desirable flavor than those from the wholesale round cut.

The above steak is known as a round bone sirloin (note round bone in lower center of cut) and is one of the most desirable steaks from this section. The lean meat has been cut across the grain, since all of the muscle fibers run in one direction. The round bone sirloin steak is well marbled and contains a small proportion of bone to meat.

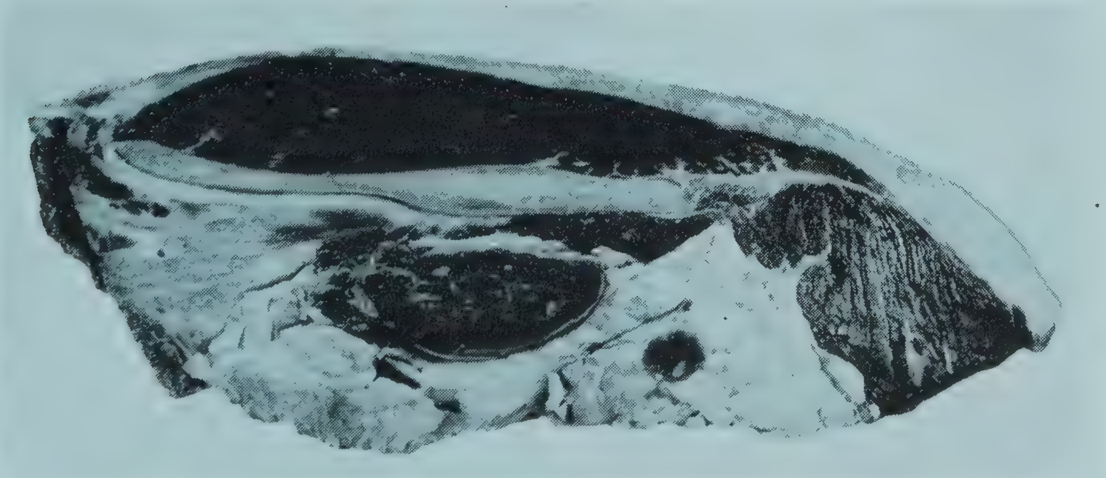

Fig. 6.—Double bone sirloin steak.

Double Bone Sirloin Steak.—The characteristics of this steak are muscle fibers running in two directions and a relatively large proportion of fat and bone to lean meat. When lean meat is cut parallel to the muscle fibers (see right of figure) it lacks tenderness, and for this reason, it is not as desirable as the round bone sirloin steak. This steak may be broiled and when cut three inches thick makes an excellent roast.

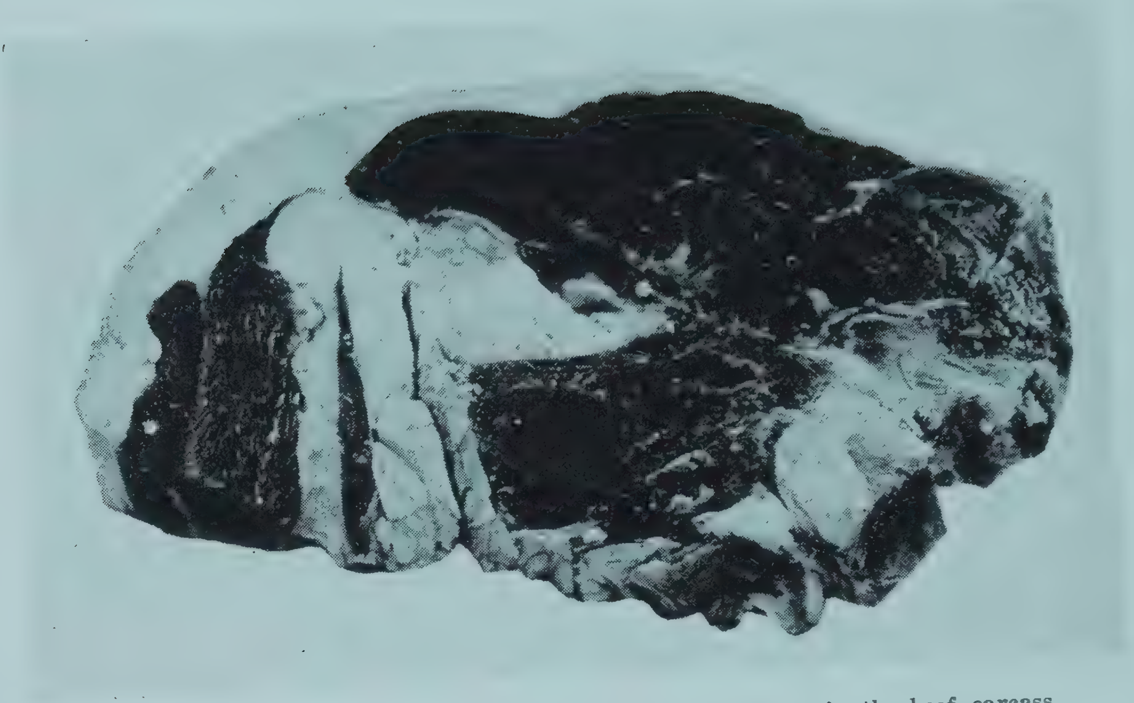

Fig. 7.—Porterhouse is considered the highest quality steak in the beef carcass.

Porterhouse Steak.—Porterhouse, T-bone and club steaks are obtained from the short loin (Fig. 2, No. 4). Porterhouse is considered to be the highest quality steak in the beef carcass. It is characterized by the T-bone conformation, large "eye of beef" above the bone, and the tenderloin muscle below. When the tail end of the steak, which is rather coarse, is cut off the resulting steak is known as a "short cut" porterhouse. These steaks should be cut about ¾ inch thick if they are to be cooked well done, but if slightly rare meat is preferred, 1 to 1½ inches is not too thick. Porterhouse, because of its flavor and tenderness, is in greatest demand and, therefore, is the most expensive cut in the beef carcass.

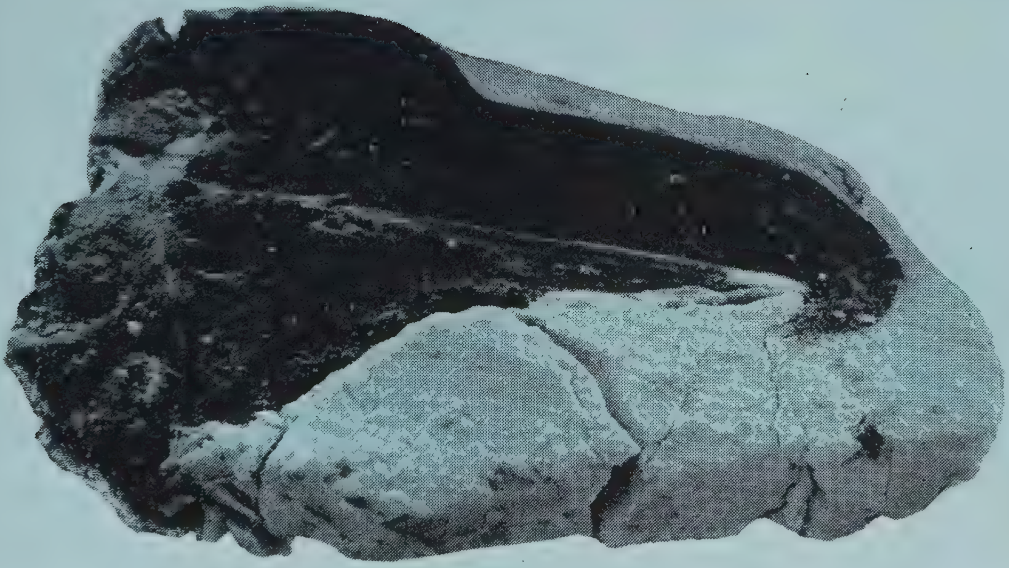

Fig. 8.—T-bone steak is similar in quality to porterhouse.

T-Bone Steak.—T-bone steak can be recognized readily by the distinct T-bone formation. This steak shows a considerable portion of tenderloin muscle, but usually there is much less than in porterhouse steak, or none at all. The "eye of beef" above the bone is similar in quality to that of the porterhouse. This cut, as indicated in the figure, contains a considerable quantity of kidney fat or suet. It is cut and cooked as is porterhouse and the price is approximately the same.

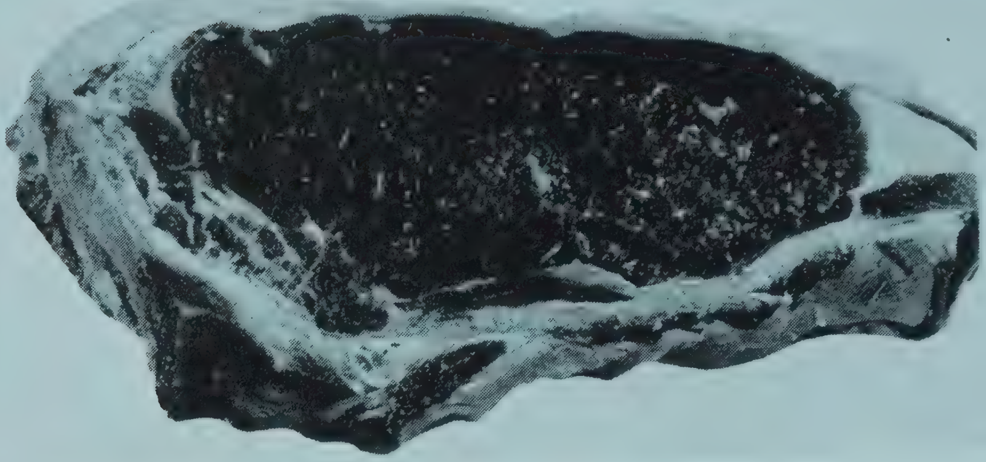

Fig. 9.—Club steak is a high quality cut.

Club Steak.—One or two club steaks are obtained from the rib end of the short loin. These steaks have neither T-bone nor tenderloin muscle, but may or may not have a rib (13th rib). Club steaks have a large "eye of beef" which in good quality beef is well marbled and surrounded on the exterior by fat. This is a high quality cut and usually is broiled. For oven broiling, 1 to 1½ inches in thickness is best. Club steaks are considered to be slightly inferior in quality to porterhouse and T-bone steaks. However, they have a higher percentage of lean to fat and bone than do the other steaks obtained from the short loin.

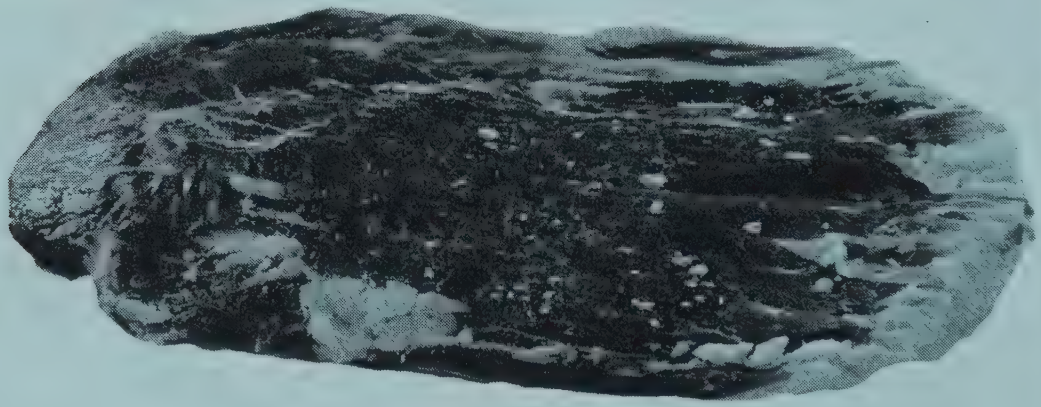

Fig. 10.—Flank steak, of medium tenderness but rich in flavor.

Flank Steak.—The flank is the cheapest wholesale cut of the hindquarter. It contains about 50 percent surplus fat and connective tissue, and very little bone. Its chief value lies in the large abdominal, flat, rectangular-shaped muscle which is known as the flank steak. The muscle fibers of the steak are large and run lengthwise. When used for Swiss steak it is scored on both sides diagonally to the fibers. When rolled with suet or fat pork it may be used as a roast. This steak is rich in flavor and when properly prepared is of medium tenderness.

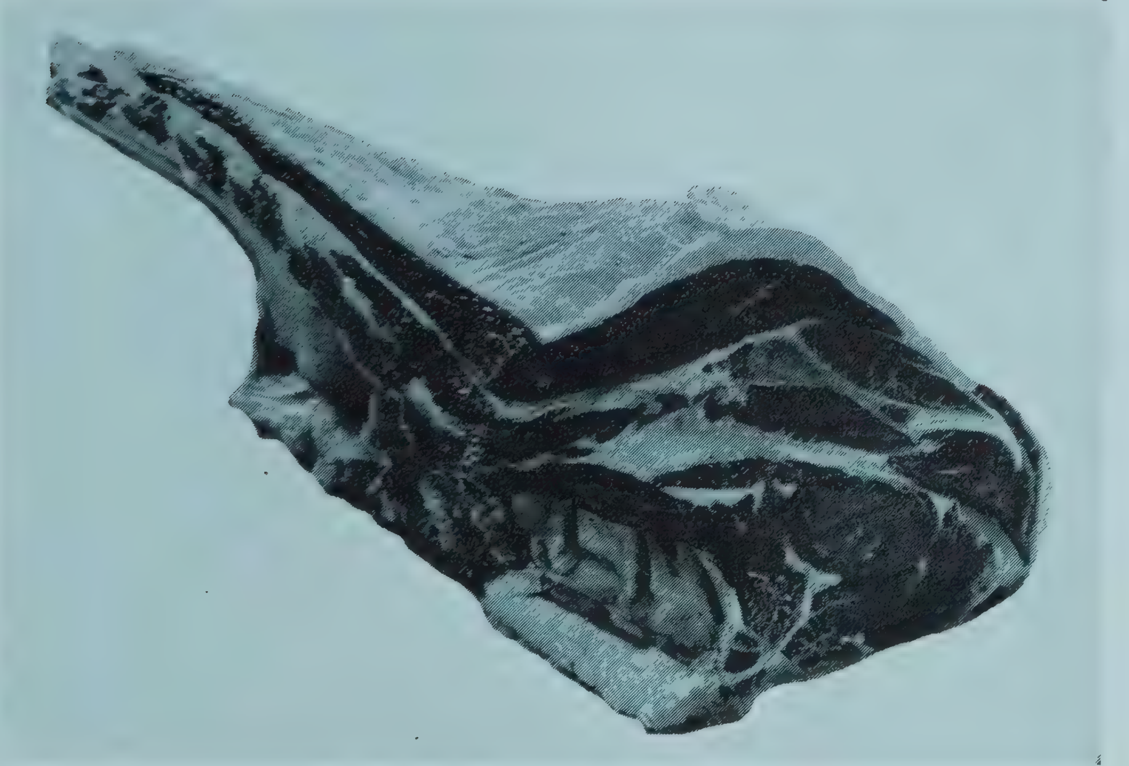

Fig. 11.—Chuck end of rib.

Chuck End of Rib.—There are 13 ribs in a side of beef. In quartering the side one rib, the 13th, is left on the hindquarter which leaves 12 ribs in the forequarter. The wholesale rib cut (Fig. 2, No. 6) contains seven ribs and corresponding sections of the backbone. Note the number of muscles which go to make up the thickness of this cut and the small cartilagenous section of the shoulder blade at the upper edge of the cut.

Rib Roasts.—Retail roasts from the wholesale rib cut are the choicest roasts in the whole carcass. These roasts have the least bone of any forequarter cut and there is usually sufficient fat on the exterior and intermingled with the lean to baste it naturally as it cooks. Rib roasts are sold as standing, folded or rolled. The first cut from the loin end of the rib is known as the 11th and 12th rib roast; the middle cuts—the 9th and 10th, and the 7th and 8th rib roasts; the chuck end as the 6th rib roast. The weight of the 6th rib cut is about equal to that of the 11th and 12th rib cut. The prepared folded rib roast shown in Fig. 1 (Cover) was taken from the 9th and 10th rib section.

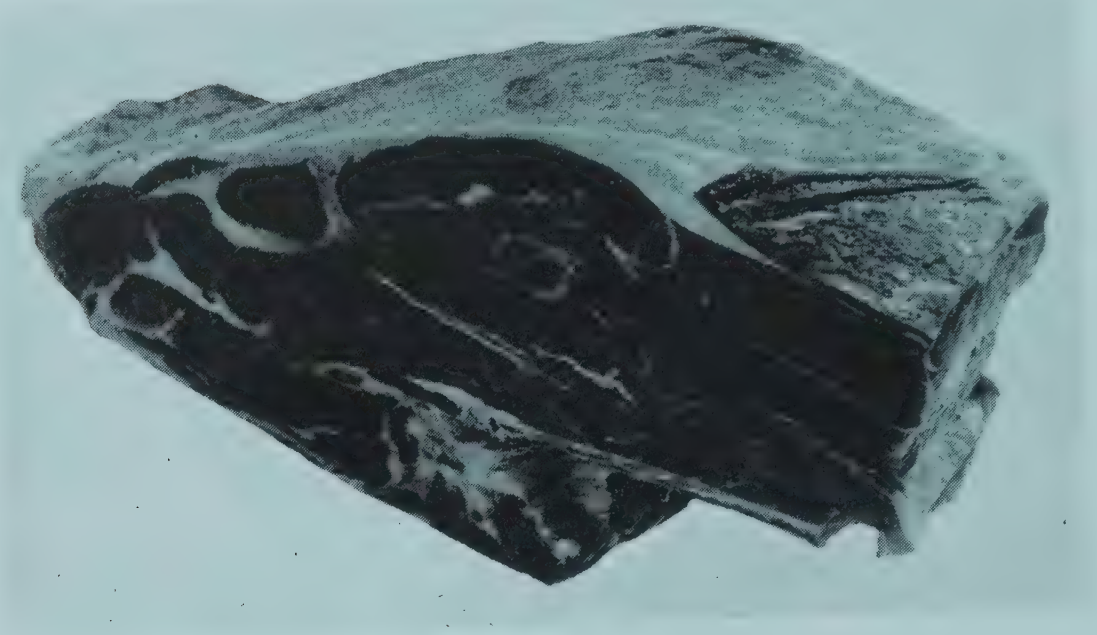

Fig. 12.—Chuck rib roast, which is well flavored meat.

Chuck Rib Roast.—The square cut chuck (Fig. 2, wholesale cuts 10, 11, 12 and 13) has many small muscles and as the muscle bundles run in various directions, it is impossible to cut all the muscles across the grain. The chuck has a relatively large amount of connective tissue, little fat and a fairly high percentage of bone. The retail cuts may be made in various shapes and sizes. The chuck rib roast consists of two ribs with corresponding vertebrae and part of the shoulder blade. It is made up of a number of muscles, contains a moderate amount of fat and a considerable quantity of bone. A chuck rib roast from a carcass which grades "medium" or higher makes a satisfactory roast or it may be cut into chuck steaks. It is well flavored because it contains a relatively large amount of meat extractives.

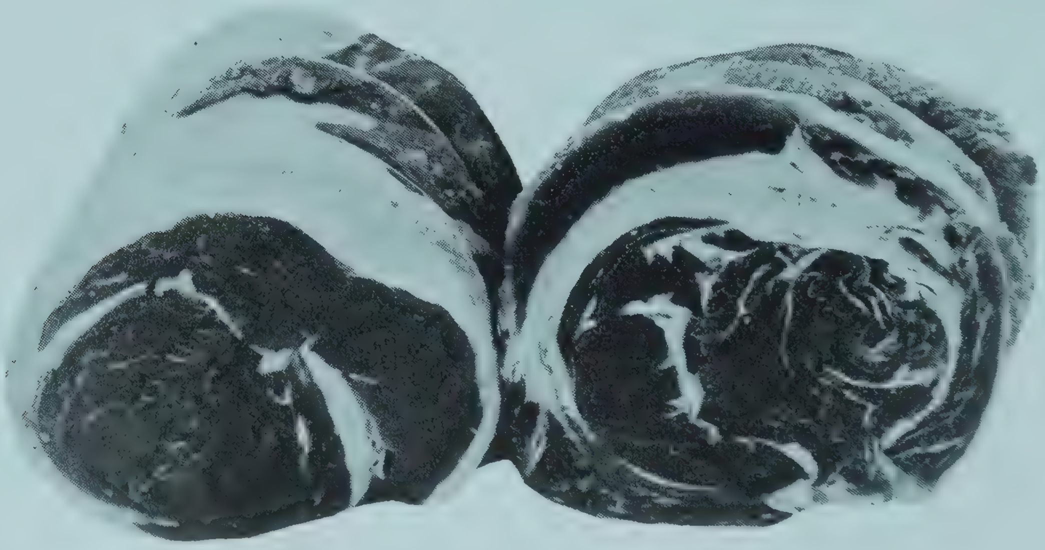

Fig. 13.—Boned and rolled chuck rib roasts.

Boned and Rolled Chuck Rib Roasts.—The chuck rib roast when taken from a medium-sized carcass may be too large for a small family. Figure 13 (page 16) shows this roast boned and made into two rolls. Each of these rolls weighs approximately 4 pounds. The rolls contain no bone, a good proportion of lean and fat which is well distributed, and very little connective tissue. The roll on the right is from the section next to the ribs and is considered to be the tenderer of the two, whereas the roll on the left contains the exterior fat. The quality of these roasts is excellent and there is no waste.

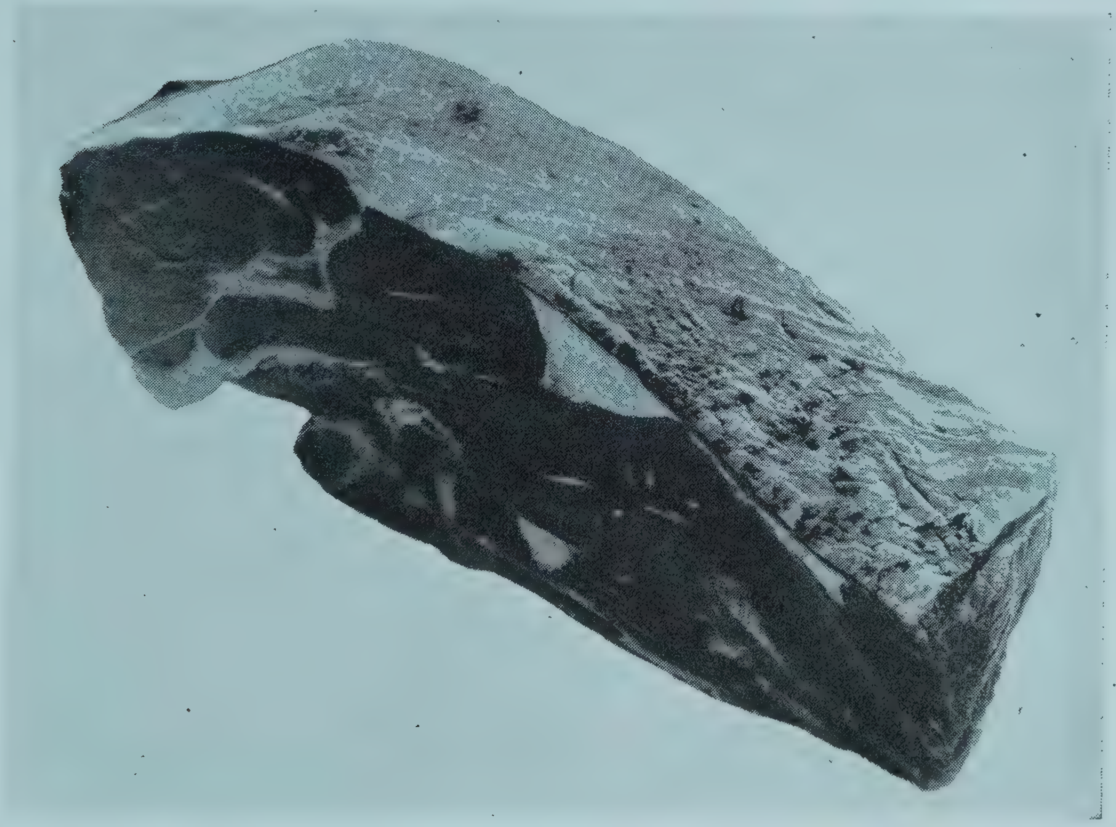

Fig. 14.—Chuck roast.

Chuck Roast.—The chuck roast is similar in muscle structure, fat content, and quality of lean to that of the chuck rib roast. It contains a small end of the shoulder blade, two ribs and corresponding portions of the backbone. When taken from a medium or higher grade carcass, it makes a good roast or it may be used for steaks. It may be cooked as a pot roast or used for braising. Because of its size it is often cut crosswise, making two roasts or it may be boned and divided into top and bottom rolls.

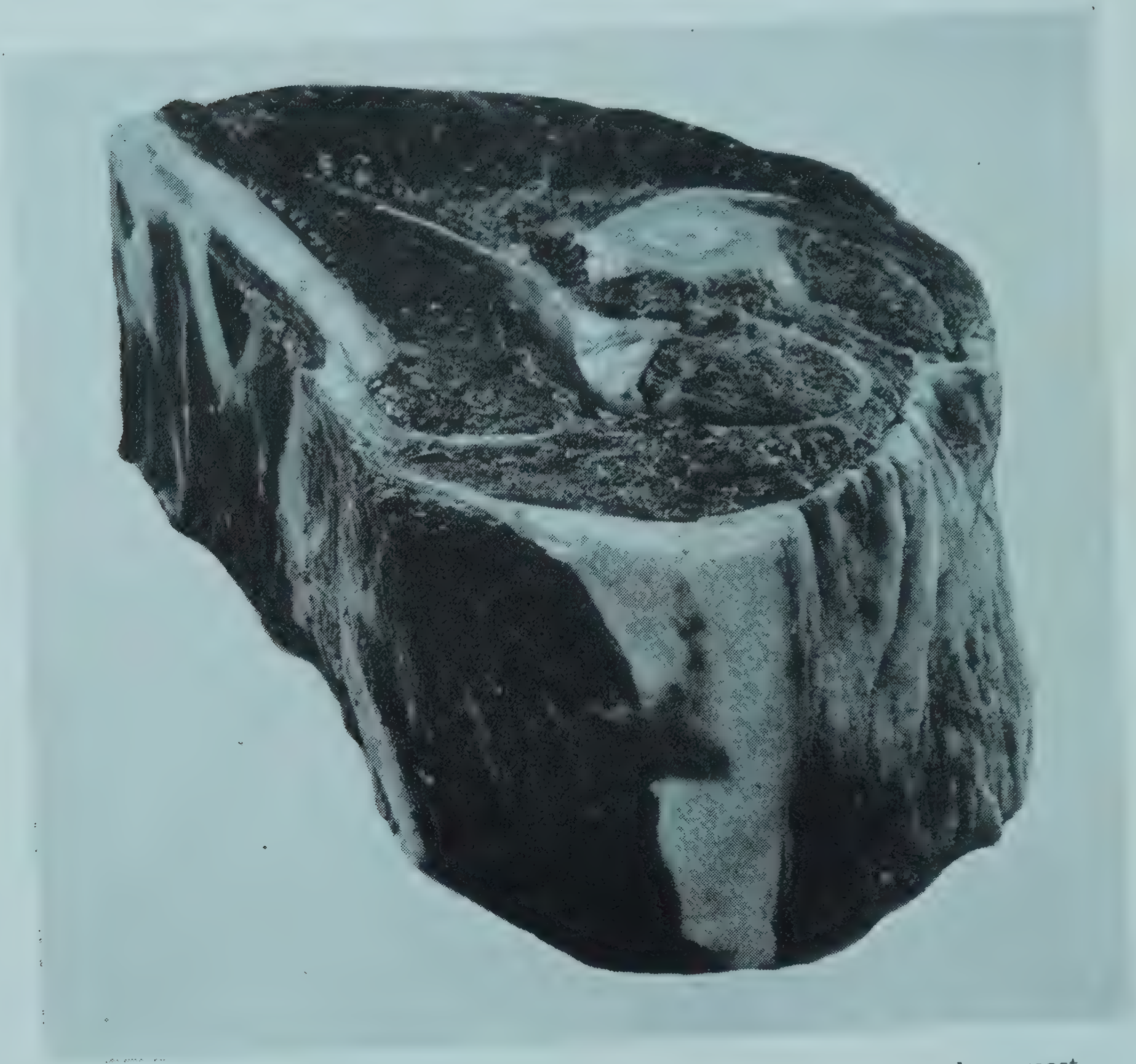

Fig. 15.—Round bone pot roast, also known as cross rib roast or arm bone roast.

Round Bone Pot Roast.—Round bone pot roast is cut across the ribs and at right angles to the chuck roasts (see Fig. 2, No. 12). It is known also as cross rib roast or arm bone roast because it is cut across the ribs and has in the center the small round arm bone. The short ribs may be removed as has been done in this cut. It may be cut into steaks for pan frying, and when cut of suitable thickness it is used for Swiss steak. When cut into steaks it sometimes is sold as round steak. It differs, however, from the round steak in that the muscles are smaller and it has a characteristic small round muscle near the bone.

Neck End of Chuck.—The neck end of chuck as pictured (in Fig. 16) shows a large proportion of lean meat. However, this piece contains the large shoulder knuckle, one rib and all of the neck vertebrae. In good quality carcasses, one or two pot roasts can be cut from the thicker part. These will be similar in quality and texture to the chuck roast (Fig. 14). The neck proper is well flavored meat, but lacks tenderness. Boneless neck, because of its flavor, is one of the most desirable cuts for ground beef. Chopping or grinding finely divides the connective tissue present and thus the meat is made tender. It also makes excellent stew meat.

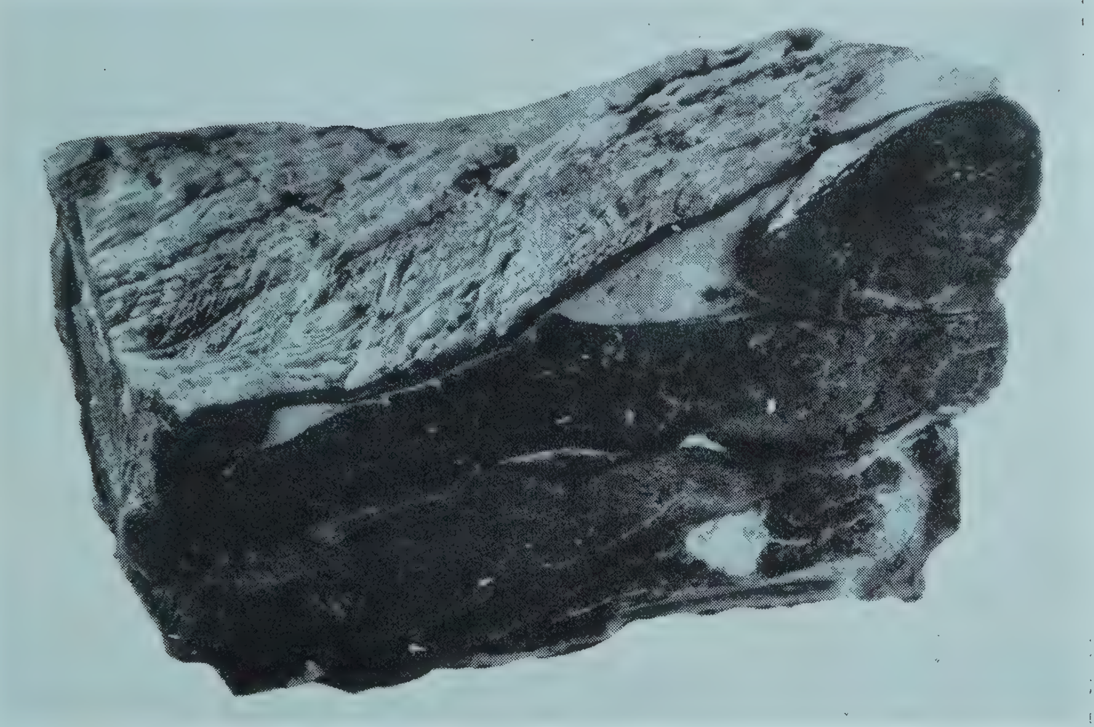

Fig. 16.—Neck end of chuck.

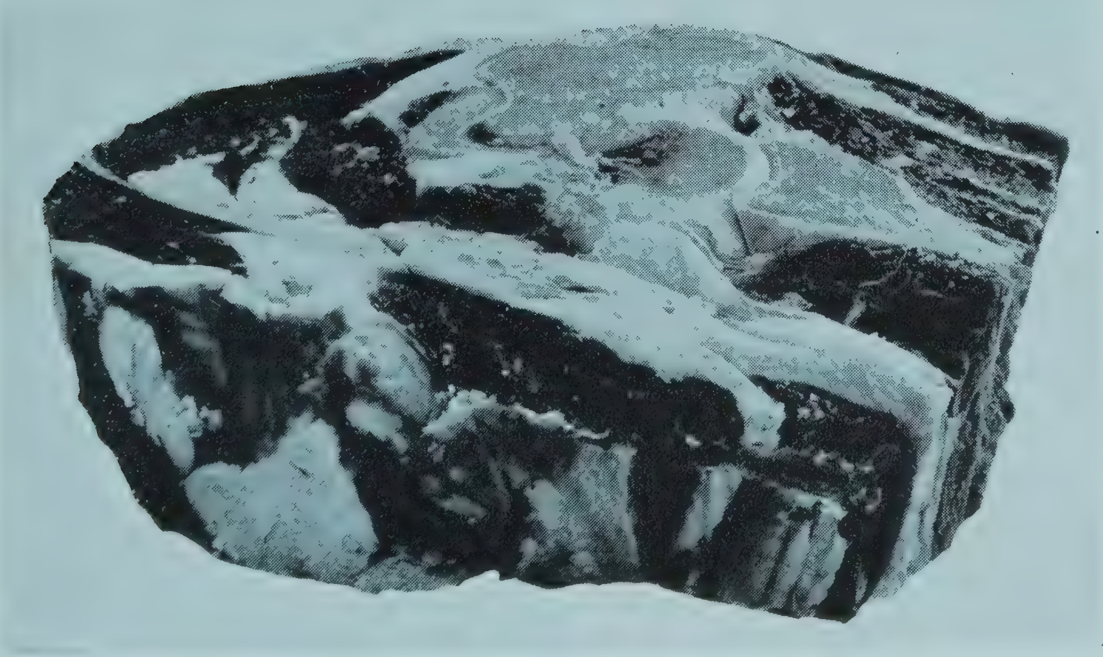

Fig. 17.—Shoulder or soup knuckle.

Shoulder or Soup Knuckle.—The shoulder or soup knuckle contains a large amount of bone, connective tissue and varying amounts of lean meat, depending upon the method of cutting. This cut, as the name implies, is used for soup.

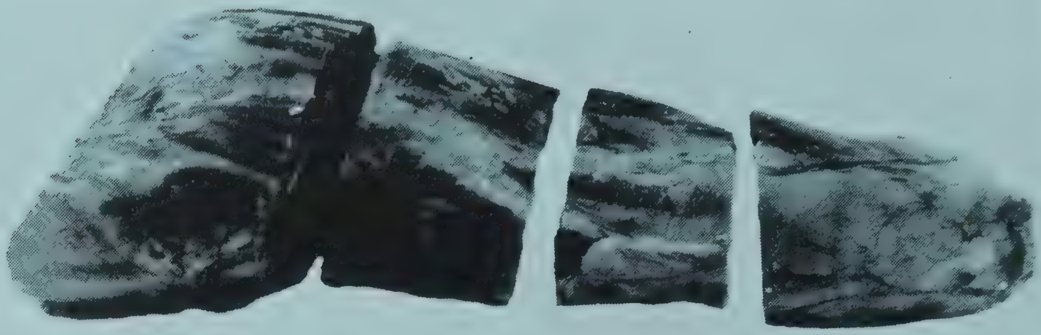

Fig. 18.—The fore shank.

Fore Shank.—The fore shank has a large amount of bone and connective tissue. The connective tissue makes it a highly desirable cut for soup or for pressed or jellied beef. A small pot roast or several shoulder steaks may be cut from the larger or upper end. The lower part of the shank is cut into 2 or 3-inch lengths to use for soup, or the meat may be used for stew or ground beef.

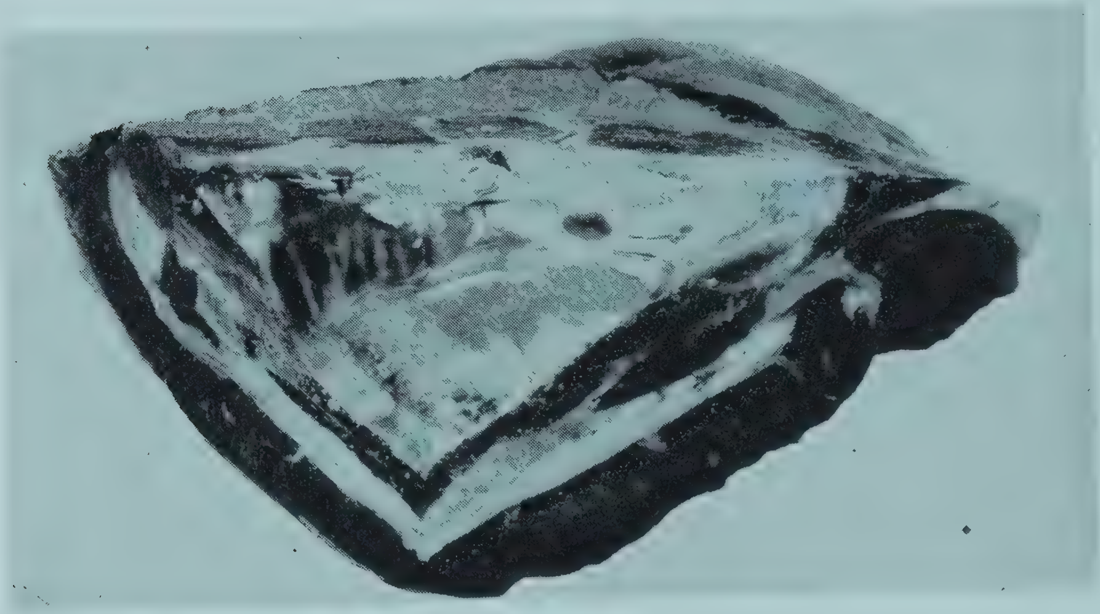

Fig. 19.—The brisket.

Brisket.—The plate of beef consists of the navel and brisket (Fig. 2, Nos. 7 and 8). The lean and fat, which are well flavored, are deposited in alternate layers. The plate contains the lower end of the ribs and breast bone. The brisket can be identified from the navel by the presence of the breast bone and the granular nature of much of the exterior fat. There is a large amount of bone and fat, and the fat when cooked has a sweet flavor. This cut is used for soup, stews and ground beef.

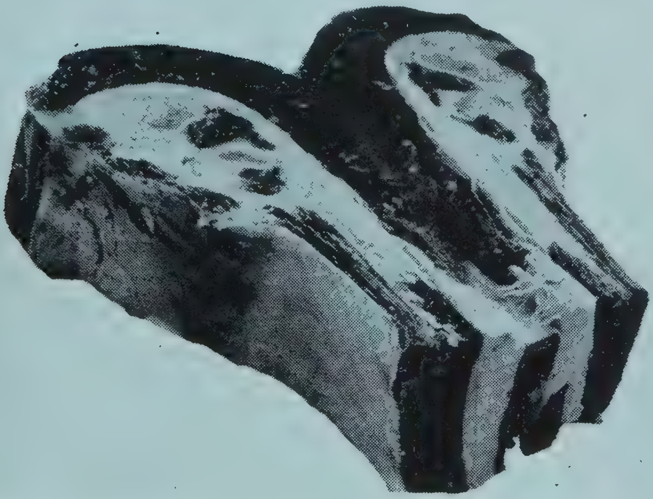

Fig. 20.—Boiling pieces from plate.

Boiling Pieces from Plate.—Sections consisting of two or more rib ends are cut from the plate and sold as boiling beef. Note the alternate layers of lean and fat in the folded cut. These cuts usually have moderate amounts of fat and the lean is well flavored.

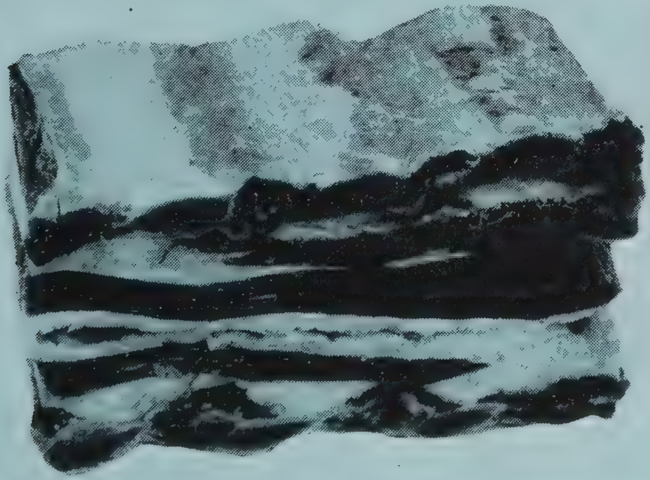

Fig. 21.—Short ribs of beef, used for boiling or as a pot roast.

Short Ribs of Beef.—Short ribs of beef are cut from the upper portion of the navel. They are cut from two to four inches in length and are used for boiling or as a pot roast. The short ribs are considered to be the best part of the plate.

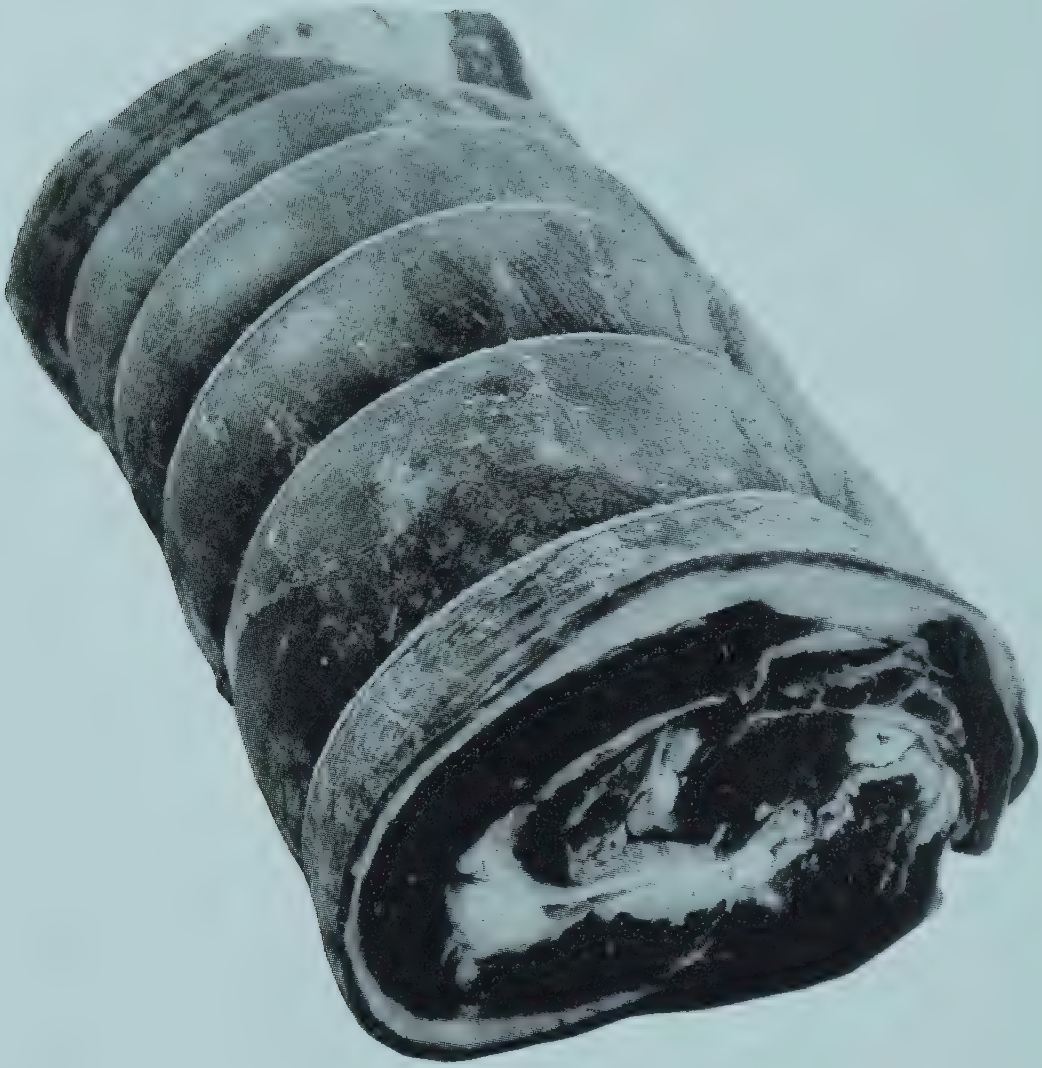

Fig. 22.—Boned and rolled navel.

Boned and Rolled Navel.—The navel piece can be boned, rolled and cut into pieces of any desired size. Note the thin outside lean portion which is fibrous and lacking in tenderness. The inside of the roll contains desirable proportions of lean to fat and is well flavored. If the roll contains a moderate amount of fat, it can be used as a roast. Because of the thinness of the muscles in this cut it is used more frequently for boiling or stewing than for any other purpose.

CUTS OF VEAL

Veal is the flesh of calves over three weeks and under 12 weeks of age. Good veal is dependent upon the age of the calf, its breeding and the feed and care it received from birth. Desirable conformation is indicated by a compact body which is heavily fleshed in the back, loin, and thighs. A desirable finish implies a considerable quantity of fat around the kidneys and in the pelvic region but with little on the exterior of the carcass or between the larger muscles. The flesh should be light pink in color, firm and smooth in appearance. The meat is fine-grained as the animal is immature when slaughtered.

The flesh of veal, when exposed to the air, dries out and turns dark more rapidly than does beef. For this reason the hide is left on the carcass at slaughtering time. Veal cannot be ripened satisfactorily because of the absence of sufficient fat, and the watery nature of the flesh. Therefore, it should be used within a short time after it has been slaughtered.

Veal is used for roasts, chops or stewing. The thickness of the carcass determines whether it is to be used for roasts or chops. The larger carcasses are used frequently for roasts, while the smaller ones are cut into chops.

The neck, which is made up of long muscle fibers and contains a large amount of both bone and connective tissue, is used for stews or soup. The fore shank has a high proportion of connective tissue and bone and is excellent for soup. The muscles of the breast of veal often are separated and sold as "pocket" veal to be stuffed and roasted. The breast may be left on the ribs and shoulder and the whole boned and included in a roll for roasting. Breast of veal, as with neck, is frequently cut in small pieces and sold as stew meat.

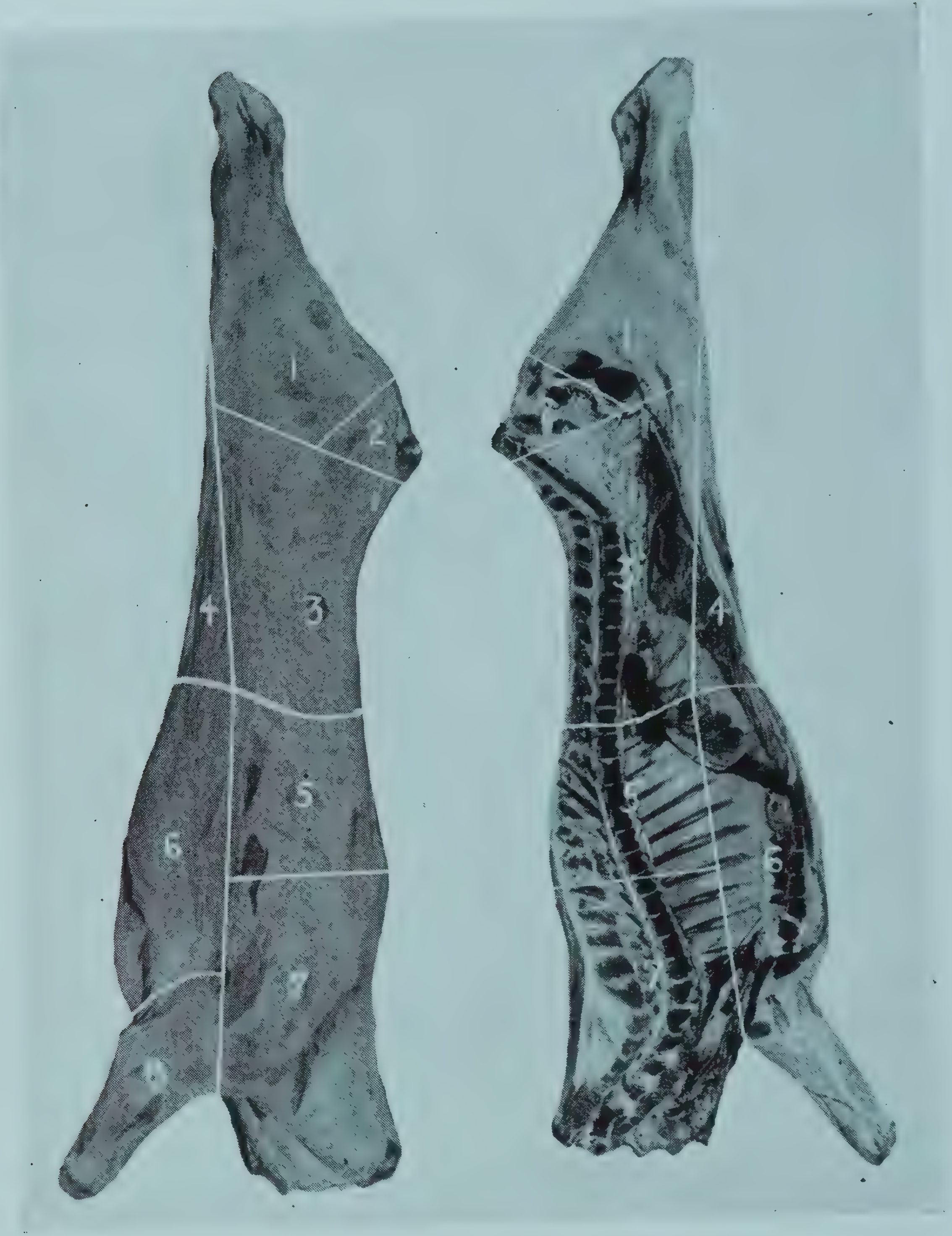

Fig. 23.—Side of veal, outside and inside views, showing wholesale cuts.

Side of Veal.—The following wholesale cuts are shown.

1. Leg
2. Rump
3. Loin
4. Flank
5. Ribs
6. Breast
7. Shoulder
8. Fore shank

Note the absence of large quantities of fat on the exterior, around the kidneys and in the pelvic region, also the light color of the flesh compared with that of a beef carcass.

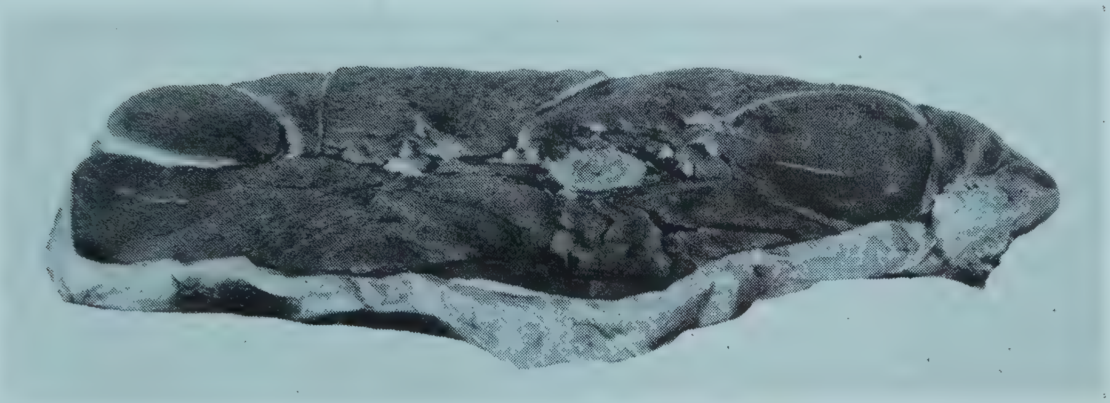

Fig. 24.—Veal cutlets, one of the most economical cuts in the veal carcass.

Veal Cutlet.—The thicker part of the leg of veal is used as veal cutlets (steaks) or roasts while the shank is used for stew meat or for soup. Veal cutlets are characterized by having a small round bone surrounded by relatively large muscles. Note the large proportion of lean to bone and fat. Veal cutlets are tender and suitable for broiling, but it is necessary to add some fat in the cooking process. They have a good flavor and are one of the most economical cuts in the veal carcass.

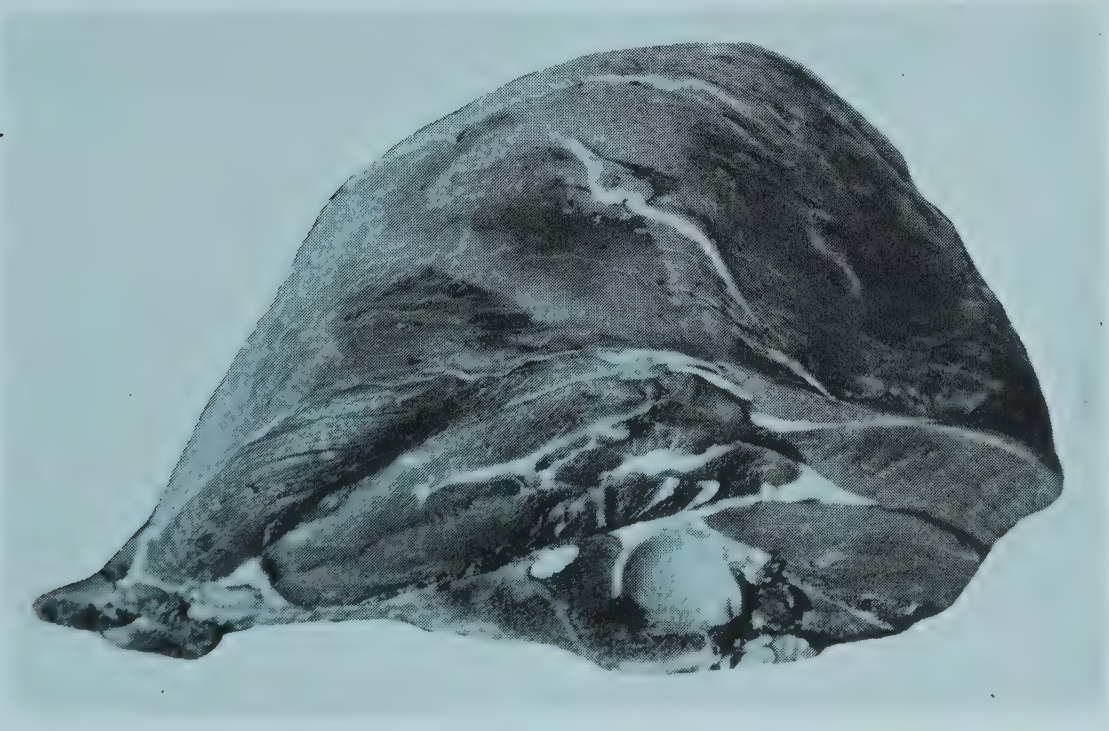

Fig. 25.—Veal roast from loin end.

Veal Roast from Loin End.—The entire loin of veal can be used for roasts or chops. This cut shows a roast from the round or rump end of the loin. The bone in the lower part of the picture is part of the femur socket. Note the lack of fat and that some of the muscles have been cut along the muscle fibers.

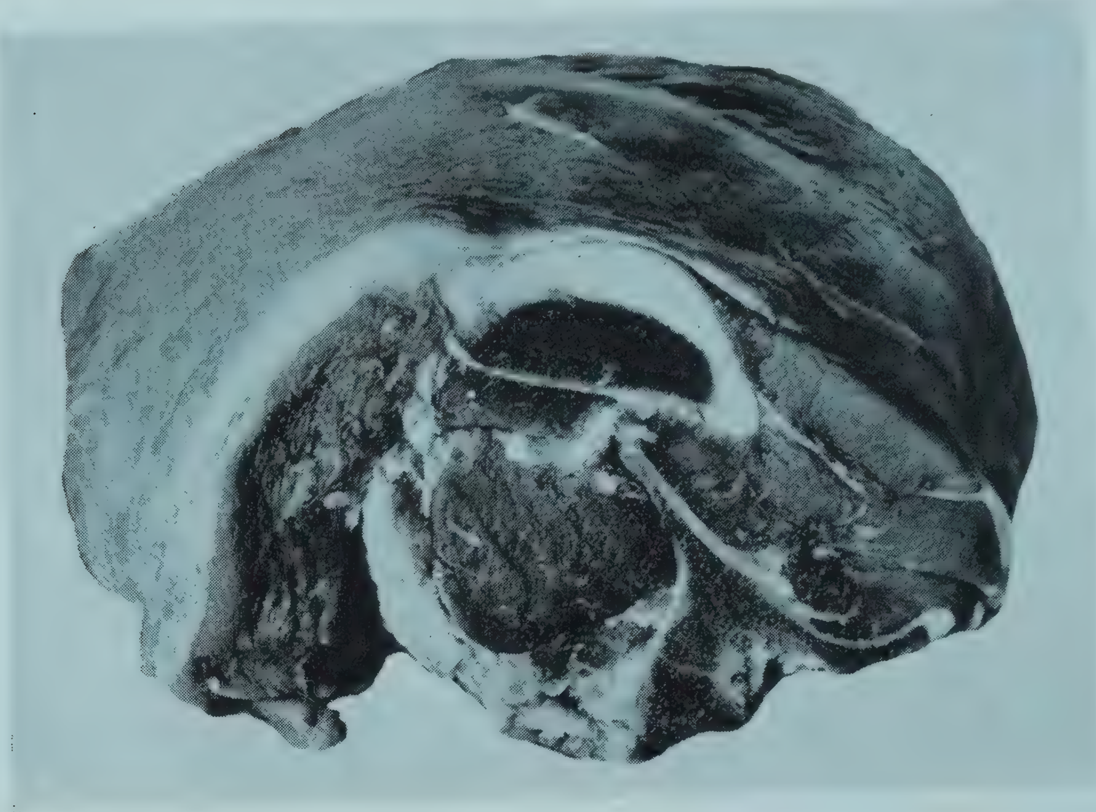

Fig. 26.—Veal roast from the loin.

Veal Roast from the Loin.—This cut shows the section of the loin end next to the short loin. Note the difference in bone and muscle structure compared with the roast in Fig. 25. No two chops obtained from the loin end are the same in muscle and bone because of the changing position and shape of these structures.

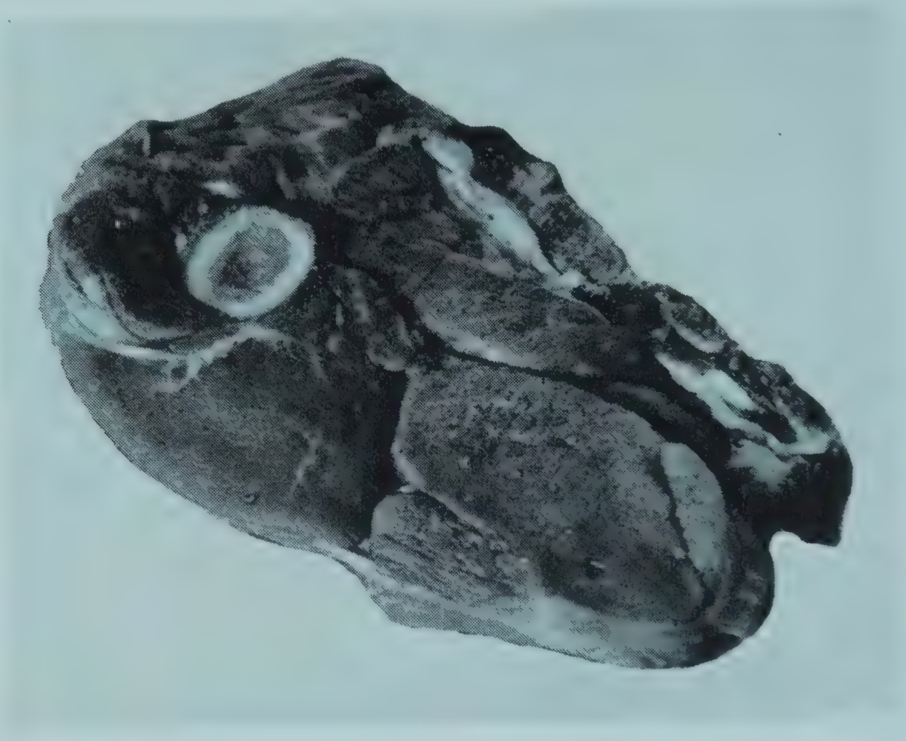

Fig. 27.—Round bone roast of veal.

Round Bone Roast.—This roast gets its name because it contains part of the arm bone which is round. It is known also as "cross the rib roast" because it contains a short section of three ribs. The round bone roast contains a large proportion of lean meat to bone and fat and is considered one of the most economical cuts from the forequarter. Although the roasts or chops from the shoulder of veal are not as choice as those from the rib and loin, they are tender and well flavored. (Fig. 27.)

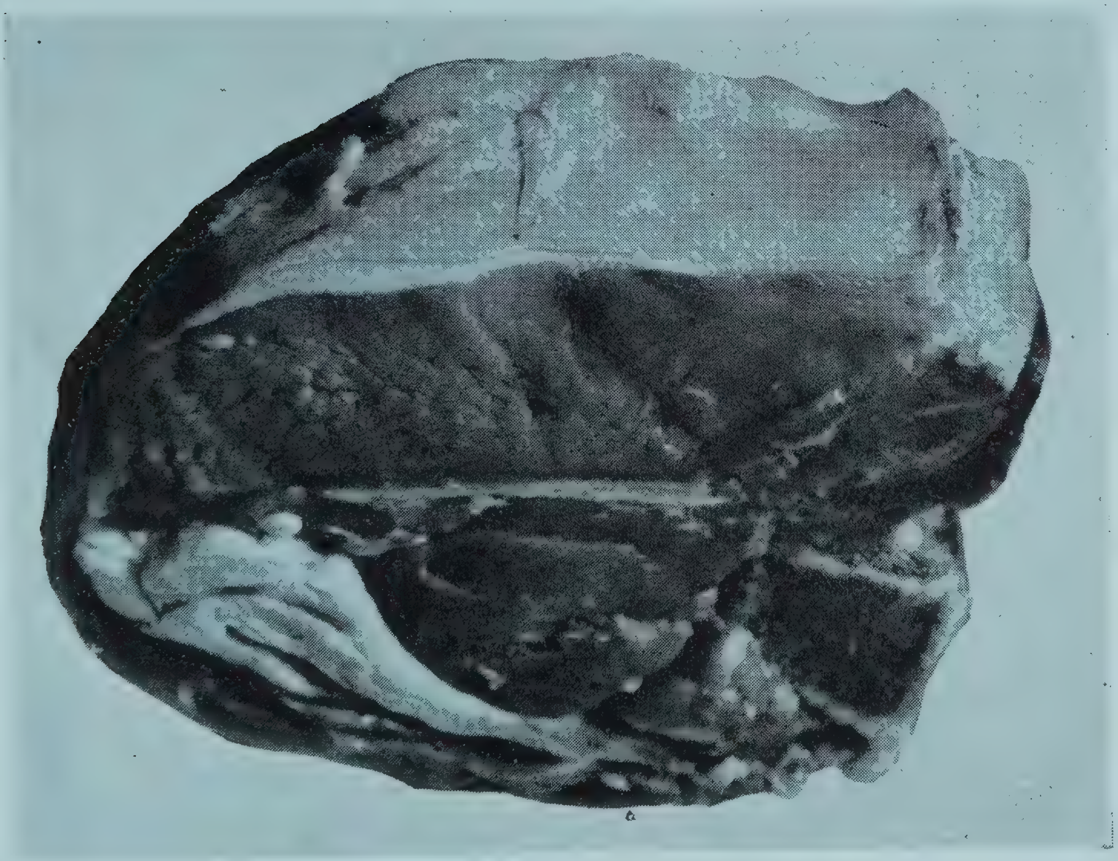

Fig. 28.—Veal roast from the short loin.

Veal Roast from the Short Loin.—This roast is characterized by the presence of the T-shaped bone, the large muscle above and the round tenderloin muscle below the bone. There is little exterior or kidney fat and the thin part of the cut has been folded under. Chops from the short loin are considered to be the choicest in the veal carcass.

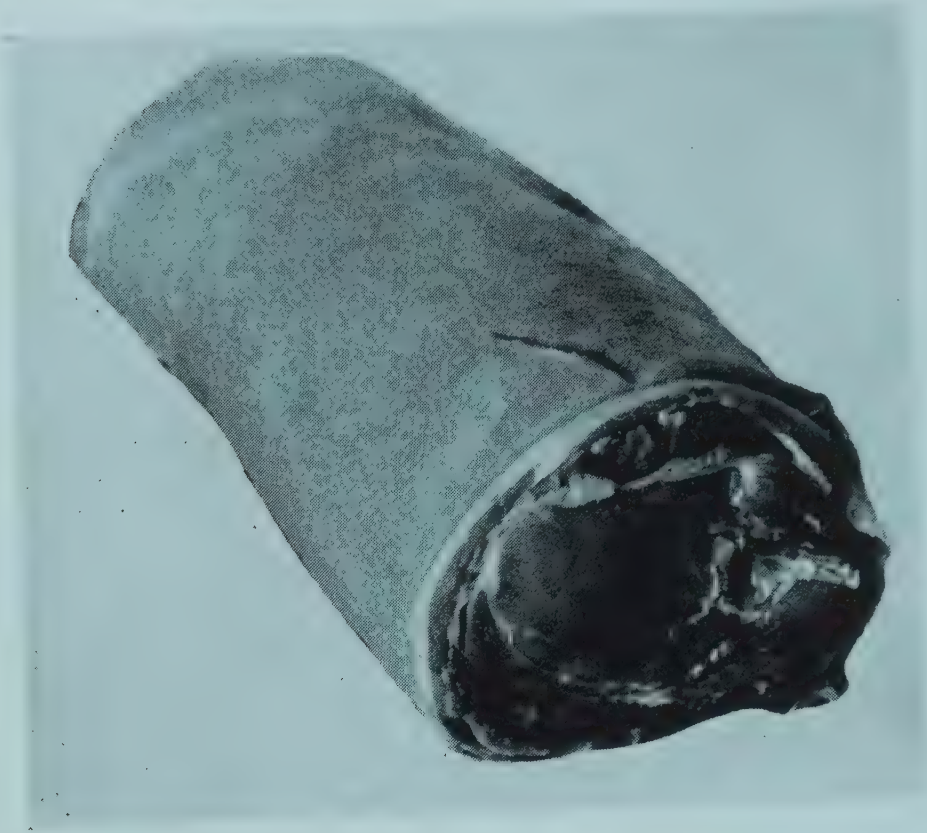

Fig. 29.—Boned and rolled rib roast of veal.

Boned and Rolled Rib Roast.—Standing or folded rib cuts from a veal carcass are rather thin for roasting. The above picture shows a boned and rolled roast from the rib section. Note the large muscle in the center of the roll and the absence of fat either on the exterior or between the muscles. When the rib section is used for chops the bones are left in.

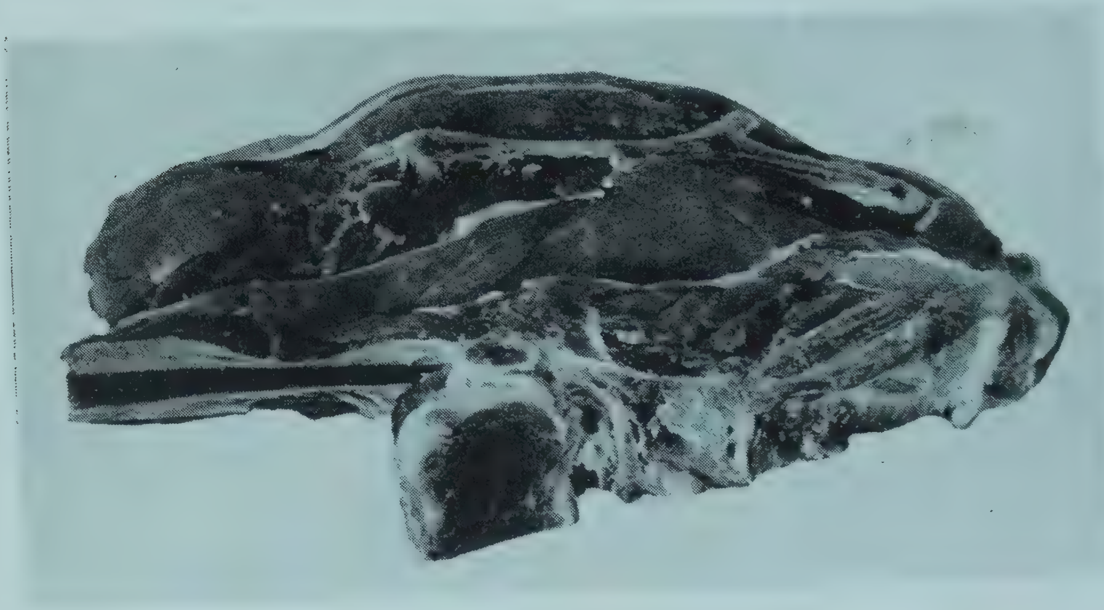

Fig. 30.—Shoulder roast of veal.

Shoulder Roast of Veal.—The shoulder roast shown in Fig. 30 contains, in addition to the ribs and backbone, a part of the shoulder blade. It is frequently boned and rolled when sold as a roast but when cut into chops the bones are left in. Note the number of muscles in this piece, some of which are cut parallel to the muscle fibers.

METHODS OF PRESERVING BEEF

Meat is a perishable food product and unless it is kept at or below the freezing point, or is canned or cured, it will decompose very rapidly. Enzymes in the meat break down the tissues (ripening) which if allowed to go too far produces an undesirable product. Meat spoilage is due to the action of bacteria which are found everywhere in Nature. This makes it impossible to keep fresh meat from becoming contaminated and, therefore, all methods of preservation of meat are based upon either checking the growth of or destroying the bacteria.

The freezing method as carried on in many rural and urban communities is to cut the chilled carcass into retail cuts, as steaks, roasts or boiling pieces, wrap each piece in oiled paper and place it in a freezing room which is kept below 0° Fahrenheit. After the meat is frozen it is stored in individual lockers in a room kept at a temperature below 15° F. As the meat is required in the home a piece of the desired size and quality can be obtained from the refrigeration plant. The low temperature inhibits all bacterial growth and the meat is kept in a perfectly fresh state.

In the canning method all bacteria are destroyed by heat and the air-tight containers prevent contamination from the outside. For further information on the canning of meat see Florida Agricultural Extension Bulletin 87, "Meat Canning", by Isabelle S. Thursby.

FACTORS INVOLVED IN MEAT CURING

The four basic factors involved in all meat curing are: (1) fresh, wholesome meat; (2) cleanliness; (3) sufficient salt to check bacterial growth; and (4) low temperature to check bacterial activity until the salt has had time to penetrate to the center of each piece.

Fresh, Wholesome Meat.—The health of the animal should receive first consideration as a sound article of food cannot be obtained from an animal that is not in thrifty condition. Beef for curing should be put into cure immediately after the carcass is chilled, while still perfectly fresh.

Cleanliness.—Cleanliness at time of slaughtering, handling and cutting up of carcass and in all of the curing processes is essential. All tools and equipment should be scalded thoroughly before meat is cut or packed in curing containers.

Curing Ingredients.—Common salt is the basis of all meat curing and is the only absolutely necessary ingredient. A good grade of dairy salt, or salt intended for table use, is reasonably free from impurities and gives better penetration than impure or coarse salt. When salt is used alone, it tends to make the lean tissues dry and hard by driving out the water and meat juices.

Sugar is used to give flavor, to make the meat juicy and to counteract the hardening influence of the salt. Brown sugar usually gives a more pleasing flavor than white sugar and syrup may be used in place of either of these.

Saltpeter is a strong preservative but it is harmful if eaten in large quantities. The purpose of the small amount of saltpeter added is to give the characteristic bright pink or red color to the cured product. Without saltpeter the cured meat will be gray in color as it comes from the cure.

Temperature.—Curing can be accomplished most satisfactorily when the meat is kept under refrigeration where a range of temperature between 32 to 38° F. is maintained. At these temperatures the bacterial growth is held in check and salt penetration is rapid. Above 40° F. the organisms which cause meat spoilage grow rapidly and there is danger of bone taint before the salt penetrates to the center of the cut, while below 32° F. the rate of salt penetration is retarded and it is difficult to obtain a uniform cure throughout the thicker cuts of meat.

CORNED BEEF

Corned beef is prepared from the cheaper cuts such as plate, chuck and shank, although other cuts may be used. Meat that is well marbled makes a more desirable product than meat which is lacking in fat. The following recipe has been found satisfactory:

100	pounds of beef
8	pounds of salt
3	pounds of brown sugar (white sugar or syrup may be used)
3	ounces of saltpeter
5	gallons of water

The most desirable containers are large earthenware jars, but because of the danger of breakage wooden tubs or barrels are used. A clean, tight hardwood vinegar or syrup barrel will answer the purpose. It should be thoroughly scrubbed and scalded before being used. If there is any odor in a new barrel it can be removed by repeated scaldings or by allowing salt water to stand in the barrel for several days. Do not use a barrel made of resinous wood as the meat will taste of resin.

In corning, cut the meat in pieces of uniform size (five to six pounds) and thickness to facilitate packing. Rub each piece of meat with salt and pack in the curing container. Make a pickle of the remaining salt and other ingredients and pour over the meat. If the mixture is boiled to sterilize it, be sure the solution is well cooled before pouring it over the meat. Weight down with a clean board and stone. Keep at a temperature from 32 to 38° F. Repack the meat on the fourth and eighth days to insure uniform penetration of the curing mixture. The meat will be ready for use in 10 days, but will be at its best in 15 to 20 days. The meat must be kept in the brine until used. If it becomes too salty the excess salt can be removed by soaking in water or by parboiling.

DRIED BEEF

The large muscles of the round commonly are used for dried beef but any thick muscled piece may be used. The higher the quality of meat the better will be the finished product. The round usually is separated into three parts by following the natural division between the muscles. When this is done the meat can be sliced across the grain after it is dried and smoked. The brine and the dry method are used most frequently.

Brine Method.—The same procedure is followed in the preparation of dried beef as outlined for corned beef. Allow the meat to stay in the brine three days per pound per piece, that is, 15 days for a 5-pound piece of meat. When the meat is removed from the brine, allow it to drip and become thoroughly dry, after which it may be smoked.

Dry Method.—Less salt is required for dry than for brine curing. The following curing mixture has proven satisfactory:

100 pounds of beef
5 pounds of common salt
3 pounds of brown sugar (white sugar or syrup may be used)
3 ounces of saltpeter

Divide the curing mixture into three equal parts and rub the meat with one portion and pack in a tight vessel. Allow the meat to remain in cure for four days, remove it from the pack and rub it with a second portion of the curing mixture. Repack the meat, placing the pieces which were on top at the bottom of the pack. Repeat again in four days, using the remaining portion of the curing mixture and leave from three to five days. Any pickle which has collected in the container during the curing period should be allowed to remain to aid in the cure. When taken from the cure, the meat is washed to remove excess salt and then allowed to drip.

The cured meat is dried at a temperature of 130 to 140° F. for 30 hours. If such a temperature cannot be obtained, the meat is allowed to dry for a longer period before it is smoked.

The dried beef is smoked at a temperature of 100 to 140° F. If possible, use green, hard, non-resinous woods such as hickory or oak, but if these are not available corn cobs may be used. A light smoke for 24 hours will give a mild smoke flavor. The meat can be smoked for a longer period if a more pronounced smoke flavor is desired, or it may be smoked for a few hours every week until it is used.

PREPARATION OF MEAT FOR THE TABLE

The finest quality meat may prove a disappointment if not properly cooked. On the other hand, a low grade piece of meat may become a palatable food after it has been cooked properly. The natural meat flavors are relished by almost everyone regardless of how often meat appears on the menu. With improper preparation, much of the original meat flavor may be destroyed.

METHODS OF COOKING MEAT

The reasons for cooking meat are (1) to develop flavors; (2) to improve appearance; (3) to kill bacteria and parasites; and (4) to soften connective tissue.

The method used in the cooking of meat should depend upon the grade of the carcass and the part of the carcass from which it is taken. The more tender cuts, which have a minimum of connective tissue, are from the parts of the carcass which have been used the least in life. The muscles which have been used the most have fibers with greatly thickened walls and are surrounded by a large amount of connective tissue. Consequently, these cuts must be prepared carefully in order to obtain an appetizing food product.

There are only two ways of cooking meat, by dry heat and by moist heat. The more tender cuts which contain a small amount of connective tissue and have a moderate amount of fat are cooked by dry heat, while the less tender cuts which contain little fat and a large amount of connective tissue are cooked by moist heat. The dry heat methods are roasting, broiling and panbroiling; and the moist heat methods are braising, boiling in water and stewing.

Roast: To cook by dry heat in an oven.

Broil: To cook by direct heat from hot coals, a gas flame or electric element; to grill.

Panbroiling: To cook in a hot, uncovered frying pan, pouring off fat as it accumulates in the pan.

Boil: To cook in boiling liquid, usually water.

Braise: To brown meat in a hot receptacle in a small amount of fat, then to cook slowly in the meat juices or in added liquid (water, milk, cream, diluted vinegar, juices from vegetables) in a covered utensil.

Stew: To cook in water below the boiling point; the cooking temperature is approximately 185° F.

PREPARING THE LESS TENDER CUTS

Preparing the less tender cuts by pounding has been practiced for many years. The object is to break down the connective tissue in the meat. In doing this, meat juices are liberated and unless taken up with flour much flavor is lost from the piece of meat. Pounding with the edge of a plate does not have much effect in breaking down the connective tissue. The more modern method is to use a mallet which has blunt, knife-like edges at right angles to each other which cut the tough tissue.

The cubing machine uses the same principle of blunt, knife-like edges which are fixed in the shape of a cube. The meat is cut thin, placed in the machine and the pressure breaks much of the connective tissue, but does not cut quite through.

Cuts of meat may be scored with a knife, cutting more or less across the grain. This method is commonly used in the preparation of flank steak which has long, strong muscle fibers.

Grinding meat is one of the principal methods of making it more tender, because it breaks up the connective tissue and muscle fibers. Meat thus treated can be cooked quickly. Chopped meat may be broiled like a sirloin or porterhouse steak. It can be molded into cakes with a little pressure and then placed on the broiler to cook to the desired degree of doneness. Ground meat can be made into the form of a loaf and baked with dry heat as any roast is cooked.

Less tender cuts of the carcass used for ground meat are likely to lack sufficient fat to be well flavored. The grinding of some suet with the lean will correct this, and fat will help retain the meat juices in the patty or loaf. Ground meat with sufficient fat incorporated will baste itself naturally as it cooks.

Larding of the lean, less tender cuts of meat adds to the flavor and prevents dryness. Small strips of fat salt pork or bacon are spaced throughout the piece of beef by means of a larding needle. As the meat cooks, the fat melts through the meat giving it added juiciness and flavor. Slices of fat pork are sometimes placed on the top of a piece of lean beef and as it cooks the melted fat runs down and through the meat.

ACKNOWLEDGMENTS

The authors wish to express their deep appreciation to Harold Mowry, Assistant Director, Administration, for making the pictures contained herein. They also wish to acknowledge the help of R. M. Crown, Assistant Animal Husbandman, in the preparation of certain parts of this bulletin.

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HEMORRHAGIC SEPTICEMIA:

THE SIGNIFICANCE OF *Pasteurella boviseptica* ENCOUNTERED IN THE BLOOD OF SOME FLORIDA CATTLE

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HEMORRHAGIC SEPTICEMIA:

THE SIGNIFICANCE OF *Pasteurella boviseptica* ENCOUNTERED IN THE BLOOD OF SOME FLORIDA CATTLE

By D. A. Sanders

The *Pasteurella* or hemorrhagic septicemia group of organisms is widely distributed. They have been reported to occur in soil, in slow flowing and stagnant water, in dead organic matter, within the digestive and respiratory tracts of wild and domestic animals, and in the blood and tissues of laboratory animals that succumb after exposures to these organisms.

Samples of heart blood and portions of internal organs of cattle that have died on the range and from cattle in dairy herds in various sections of Florida, frequently have been sent to the veterinary laboratories of the Florida Agricultural Experiment Station for diagnostic purposes. The usual history accompanying such material showed that the disease was sporadic in occurrence and that affected animals exhibited lesions suspicious of hemorrhagic septicemia. Organisms isolated from this material, upon detailed study of their cultural, morphological and biochemical characteristics together with the pathogenicity for small experimental animals, showed that they belonged to the *Pasteurella* group. These organisms were identified as *P. boviseptica,* and as a result of these findings, studies were undertaken regarding the possible etiological relationship of these organisms to the losses that Florida cattlemen and dairymen had experienced within their herds.

LITERATURE

Various types and manifestations of bovine hemorrhagic septicemia have been described, including the peracute, acute, subacute, chronic, exanthematous, pectoral, enteric, meningeal, and others. In connection with hemorrhagic septicemia, *P. boviseptica* has been reported as being the primary organism responsible for the symptoms manifested in the disease. The disease in cattle is commonly diagnosed by means of clinical, postmortem or laboratory findings. The demonstration of *Pasteurella* in bovine carcass material of suspicious hemorrhagic septicemia cases, and its virulency for rabbits, is often accepted as demonstrating definitely that organisms of this group are responsible for the disease. Occurrence of hemorrhagic septicemia in herds of cattle frequently has been explained to result from an increase in virulence of the organism and to predisposing agents which lower the body resistance.

Pasteurella organisms have been demonstrated in the tissues of animals which died from non-bacterial diseases, notably those of filterable virus origin, including canine distemper and hog cholera, as reported by Hutyra and Marek (*4*)[1]; and feline infectious enteritis as demonstrated by Leasure, Leinhardt, and Tabener (*7*). Moore (*8*) examined the upper respiratory passage of three healthy cattle and isolated organisms not distinguishable from *Pasteurella*. Jorgenson (*5*) studied the bacterial flora of the upper respiratory passage of 250 normal cattle. He concluded that *P. boviseptica* was an inhabitant of the upper respiratory tract of a considerable percent of normal cattle and that cold and fatigue predisposes animals to attacks of these organisms. Scott and Farley (*12*) isolated *P. boviseptica* from the lungs of four general autopsy cases in cattle which had no visible lung lesions. These investigators report the presence of *Pasteurella* and other species of bacteria in the tissues secured from autopsies of cattle affected with shipping fever. Their studies suggest that, while *P. boviseptica* is often associated with shipping fever, the causative factor of the disease is exposure and improper feeding and care of animals. Sanders (*9, 10*) recovered *P. boviseptica* from the blood and tissues of cattle which died from non-bacterial diseases and concluded that demonstration of *Pasteurella* in bovine carcass material of suspicious hemorrhagic septicemia cases cannot always be accepted as a criterion regarding the etiological significance of such organisms. Studies by Andrieu, Quiroga and Ezcurra (*1*), constituting a commission appointed by the Argentine Minister of Agriculture, to investigate hemorrhagic septicemia of cattle, showed that *Pasteurella* was found only as a secondary invader in outbreaks of so-called hemorrhagic septicemia. Fitch and collaborators (*1*) state, "The work of the commission sanctions the conception actually dominant in the scientific world that hemorrhagic septicemia of cattle constitutes neither a contagious nor an infectious disease, and consequently does not present grave danger for the cattle industry nor represent a menace actual or future for the animal health of the country".

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[1] Italic figures in parentheses refer to "Literature Cited" in the back on this bulletin.

SOURCE AND MAINTENANCE OF *P. boviseptica*

P. boviseptica used in these investigations was secured by culturing jugular blood of cattle in advanced stages of shipping fever, and from the heart blood and lung tissue of calves that died of enzootic pneumonia. Other strains were secured by culturing bovine carcass material submitted to the veterinary laboratory for hemorrhagic septicemia diagnosis and by isolating organisms from enlarged joints of calves affected with omphalophlebitis. Strains also were obtained by culturing the blood of rabbits which had been previously injected intravenously with the edematous tracheal exudate and heart blood of cattle that showed suspicious symptoms of hemorrhagic septicemia. Strains were isolated from rabbits that had been injected intraperitoneally with minced portions of affected lung tissue and other carcass material of cattle suspected of having hemorrhagic septicemia. Still other strains were secured by aspirating secretions from the region of the nasopharynx of apparently normal cattle. From these secretions *P. boviseptica* was isolated by plating and by inoculating laboratory animals.

After isolation of *P. boviseptica,* the organism was grown and maintained on ferric salts agar, meat infusion broth containing ferric ammonium citrate, Kracke and Teasley's (*6*) blood culture media, and on whole blood and Difco stock culture agar containing blood. The hearts and spleens of rabbits that succumbed after exposures to the organism were ligated and removed aseptically. These tissues were used to maintain certain strains of the stock cultures. The nasopharyngeal region of cattle was artificially infected with *P. boviseptica.* The organism remained at the point of introduction for weeks, affording an additional method for maintaining cultures. Stock cultures maintained in the laboratory were transferred every fortnight and were stored at room temperature or under refrigeration. *P. boviseptica* grown and maintained under these conditions was highly virulent for rabbits as proven by intraperitoneal or intravenous inoculations in which minute quantities of the stock cultures were used.

HOUSING OF EXPERIMENTAL ANIMALS

The work was conducted in an isolation building 25x16 feet with reinforced concrete foundation and floors. The foundation extends 10 inches beyond the outer walls of the building. A circumvallate moat six inches in width built into this concrete extension and filled with strong disinfectant precludes the entrance of crawling forms of life. The concrete is continued upward to a height of two feet above the floor level, forming part of the outer walls of the structure. Upon this two-foot concrete extension, timbers are bolted and the walls proper extend upward to a height of eight feet by means of screened-in framework. The building is covered by a hip roof having a three-foot eave.

Four pens 6½x7½ feet, of steel tube panel construction set in a five-inch curb, are situated centrally within the building. Floors in the pens slope to a common drain six inches in width. Removable wooden slatted platforms of low construction, upon which the animals rested, were placed in each pen. Floors and platforms were scrubbed and washed daily. Drainage is conveyed to a septic tank. An observation and exercise alley four feet in width surrounds the pens between the walls and panels. The building is entered through a vestibule, the walls of which are of structure similar to those of the main unit.

Water is supplied to each pen through pipes leading from the city main. The building is wired for electricity. A good grade commercial dairy grain ration and beet pulp were used as feed for the experimental animals. The young calves received milk from a pail.

EXPOSURE OF CATTLE TO *P. boviseptica*

Attempts were made to produce clinical cases of hemorrhagic septicemia by exposing calves, yearlings and cows to *P. boviseptica*. The organisms used in the exposure tests were isolated from the blood and tissues of cattle and maintained as stock cultures under conditions previously enumerated. Methods of exposure undertaken consisted of feeding *P. boviseptica* in the form of 24-hour agar and blood bouillon cultures and also by feeding cultures maintained in whole blood. The internal organs and peritoneal exudate of laboratory animals which died from acute septicemia, following intraperitoneal injections or nasal sprays of *P. boviseptica*, were minced and administered as a drench. The nasal passages, conjunctival and auricular cavities of the cattle were sprayed with suspensions of the organism and bouillon cultures were introduced into the sinuses of the head through an opening made with a trephine. Experiment 1 is typical of the exposure experiments conducted.

Experiment 1: Fourteen calves ranging from one day to six months of age were exposed to *P. boviseptica* by nasal spray. Amounts varying from one to 50 cc. of a heavy suspension, prepared by washing 24-hour agar cultures in physiological saline solution, were sprayed into the nasal passages by means of an atomizer. No clinical evidence of infection occurred in animals receiving up to 20 cc. of the suspension. Several animals receiving 50 cc. as a nasal spray in broken doses over a seven-day period did not show evidence of ill effects. Four animals receiving 50 cc. into the nasal passage at a single spraying gave the following reaction: Slight increase in rate of pulse and respirations, slight elevation of body temperature, a mucopurulent nasal discharge, and a cough. These symptoms endured for about a week in two of these animals and were followed by an apparent complete recovery. However, the organism remained in the region of the nasopharynx for several weeks. The other two animals receiving 50 cc. as a single nasal spray continued to cough for a period of eight weeks following the exposure.

Repeated attempts to recover *Pasteurella* from the blood stream of these experimental animals were made during the clinical reactions. The neck was prepared by thoroughly washing with soap and water. An area over the jugular vein was selected, shaved and swabbed with 70 percent alcohol, after which it was painted lightly with tincture of iodine. Blood in various amounts was collected directly into culture tubes and flasks containing Kracke and Teasley's blood culture medium. This collection was made by use of a 16-gauge needle attached to and sterilized as an integral part of the bleeding apparatus. Whole blood was collected from the jugular vein with sterile glass syringes and transferred to ferric salts agar and meat infusion bouillon. All cultures were incubated at 37.5° C. for five days. Other blood samples were secured by means of sterile syringes, transferred to sterile tubes, and held at room temperature for observations. Under these conditions *P. boviseptica* has not been recovered from the blood stream of cattle thus exposed to the organism, nor has hemorrhagic septicemia been produced in any of its recognized forms. *P. boviseptica* was readily isolated by similar cultural methods from the blood stream of clinically affected laboratory animals which received intraperitoneal injections or nasal insufflations of the organisms.

P. boviseptica was recovered readily from the secretions of the nasopharynx of cattle for a period of three months after they were artificially exposed to this organism by nasal sprays. The organism was recovered from the frontal sinus two months after introduction through an opening made by means of a trephine. The organism was lethal for rabbits prior to its exposure to cattle and also after it had been recovered from the nasopharyngeal region and frontal sinuses of these exposed animals. Autopsies were made on the two experimental cows which continued to cough following heavy nasal spray exposures to 50 cc. of concentrated stock culture. The autopsies were performed after a period of eight weeks following the exposure. The apical lobes of the lungs contained several pneumonic foci one-half centimeter in diameter. *Pasteurella* was recovered from the bronchioles adjacent to these lesions. No difference was found as to the type or character of the media used in growing and maintaining *P. boviseptica* as influencing its virulency for cattle.

From these results it was concluded that the environment of the respiratory passage of cattle is favorable to the existence of *P. boviseptica;* that the body resistance in bovines is normally effective against the invasiveness of mild exposures to the organism; that factors other than bringing the bacteria and the host animal together are necessary for the organism to disseminate from the respiratory passage into the blood stream.

REDUCED RESISTANCE AND *P. boviseptica*

The predisposing factors occurring under certain local conditions were thought to lower the body resistance, thereby favoring the infection of *Pasteurella,* and to account for the presence of these organisms in the blood of cattle. Therefore an attempt was undertaken to produce clinical hemorrhagic septicemia in yearling calves by exposing them to *P. boviseptica* and at the same time reducing their body resistance.

Experiment 2: Bull H 117 was given as a drench minced liver, lungs, and heart of a rabbit which died 18 hours after an intravenous injection of *P. boviseptica.* This animal suffered no ill effects as a result of the exposure. Six days later this same bull was given 4 cc. of a 24-hour bouillon culture of *Salmonella suipestifer* as a nasal spray. The latter organism was secured as a pure culture from the blood stream of a pig that was dying of paratyphoid infection. On the third day following paratyphoid infection the bull became depressed, ceased to eat, and developed diarrhea. On the following day there appeared an increase in the pulse and respirations and the body temperature reached 106.5° F. Clinical symptoms of paratyphoid infection remained pronounced for a period of four days. During the acute reaction to paratyphoid infection bull H 117 was given intranasal sprays and drenches of *P. boviseptica* cultures. No evidence of hemorrhagic septicemia appeared following this exposure test.

Bull yearling H 118 was given 4 drams of pulverized dried *Nerium oleander* leaves as a drench in a small amount of water. As a result the animal became depressed, showed complete loss of appetite, cold extremities, and was unable to rise. The feces were loose and contained admixtures of mucus and blood coagula. Symptoms of oleander poisoning continued for four days. During this period of weakness 400 cc. of various strains of *P. boviseptica,* in the form of a 24-hour bouillon culture, was administered as a drench. No evidence of hemorrhagic septicemia developed.

An eight months old yearling was exposed by nasal spray to a heavy saline suspension of *P. boviseptica.* It was then given a total of 60 pounds of the common bracken fern, *Pteris caudata,* over a 12-day period. Intestinal hemorrhage and membranous enteritis developed during the latter portion of the feeding period as a result of eating the bracken. Numerous greyish white pseudomembranes ranging from one-half inch to 10 inches in length were evacuated in the feces. This inflammatory process of the intestinal mucosa due to ingestion of bracken was not accompanied or followed by hemorrhagic septicemia infection.

Results of Experiment 2 show that the methods used to lower the body resistance, namely: infection by *S. suipestifer,* and plant poisoning by *N. oleander* and *P. caudata,* were not sufficient to permit development of hemorrhagic septicemia in exposed cattle.

SOME SPECIFIC CONDITIONS UNDER WHICH *P. boviseptica* OCCUR IN THE TISSUES OF CATTLE

The foregoing experiments showed that many strains of *Pasteurella,* isolated from tissues of cows suspected of having had hemorrhagic septicemia, failed to produce any clinical disease in cattle which were exposed to these organisms. The methods experimentally employed to lower the body resistance also failed to establish conditions necessary to bring about invasion of the blood stream by *Pasteurella.* An analysis of the specific conditions under which *P. boviseptica* occurred in the body tissues of cattle in the field was considered next in importance.

PSEUDORABIES AND *P. boviseptica*

The inciting agent of pseudorabies or "mad itch" of cattle has been demonstrated by Shope (*13*) to be a filterable virus. The condition often is diagnosed erroneously as the exanthematous or skin form of hemorrhagic septicemia. During July 1937 observations were made on a herd of cattle in which eight animals died over a 10-day period. The last animal that died showed clinical symptoms of the skin form of pseudorabies. The symptoms observed in this case consisted of violent itching of the right mandibular region which led to persistent and continuous rubbing of the jaw on the ground, fence posts or other available objects. As a consequence the affected area became denuded of hair, mutilated, edematous, and discharged a serosanguineous fluid. As the itching developed further there occurred grinding of teeth, violent tossing of the head, rubbing of the mandibular region with the hind foot, rapid shallow respirations, anxiety, prostration and death. Postmortem lesions consisting of pulmonary edema and hemorrhages of the heart were typical of the virus infection of pseudorabies. *P. boviseptica* was isolated from the bronchial and tracheal exudate of three animals that died in the herd. Two bull yearlings which were given intravenous injections and nasal sprays of defibrinated blood from the clinically affected cattle failed to develop symptoms of septicemia.

It was concluded that *P. boviseptica* may be present in the tissues of cattle which succumb to the virus infection of pseudorabies.

ACUTE ANAPLASMOSIS AND *P. boviseptica*

In one dairy herd where losses of milk cows had occurred, *P. boviseptica* was isolated from the jugular and heart blood of an animal that died after having shown clinical evidence of a disease resembling anaplasmosis for only a short time. These findings resulted in the condition being diagnosed as hemorrhagic septicemia infection and the herd was treated accordingly. Upon examining prepared blood smears of a clinically affected animal in the herd during this period, *Anaplasma marginale* Theiler was demonstrated parasitizing the erythrocytes. The simultaneous occurrence of *P. boviseptica* and *A. marginale* in the blood of animals of this herd led to suspicion of a relationship between these agents which would explain the presence of *Pasteurella* organisms in the blood of cattle in many instances encountered in the field. This suspicion was further strengthened when, as shown previously, *Pasteurella* organisms of bovine origin having a high degree of virulence for small laboratory animals failed to produce hemorrhagic septicemia in cattle. It appeared reasonable to believe that *A. marginale* would weaken the body resistance against *Pasteurella* sufficiently to allow the development of hemorrhagic septicemia.

Experiment 3: This experiment was undertaken for the purpose of making observations on animals which were harboring *P. boviseptica* in the upper respiratory passage and at the same time approaching or passing through acute reactions of anaplasmosis. Two bull yearlings 14 months of age were exposed by nasal spray to *P. boviseptica,* using blood bouillon cultures and saline suspensions of 24-hour growth. Three strains of *Pasteurella* were used, namely E1 which was isolated from the jugular blood of a purebred Guernsey bull that died of acute anaplasmosis, E2 isolated from the synovial fluid of a young calf suffering from septic joint infection, and E3 isolated from the upper respiratory passage of a healthy cow. Before exposure, these organisms proved to be virulent for small laboratory animals. One one-thousandth cc. of a 24-hour bouillon culture proved fatal for rabbits in 18 hours when injected into the peritoneal cavity or when a drop of the undiluted suspension was placed on the nasal mucosa. The yearlings withstood the exposure without evidence of a clinical reaction. To determine if these animals were free from *A. marginale* infection or whether they were recovered carriers of anaplasmosis, a surgical operation for removal of the spleen was performed. In general, the technique of de Kock and Quinland (3) was followed in performing the splenectomies. Recovery from the operations was uneventful in both animals. Healing of the operative areas without infection was secured. Careful clinical observations and blood examinations of these animals were made over a period of 30 days following removal of the spleen. No evidence of anaplasmosis appeared following the splenectomies. This indicated that the animals were not carriers of *A. marginale.*

Thirty days following the splenectomy, each of these animals received intrajugular injections of 5 cc. of citrated blood obtained from a cow which was suffering from an acute attack of anaplasmosis. Acute reaction to the parasitic invasion of *A. marginale* occurred. Blood examinations and clinical symptoms during the attack showed a typical picture of anaplasmosis. Approximately 50 percent of the erythrocytes became parasitized. This resulted in a marked anaemia which was accompanied by the usual blood changes characteristic of severe hematozoon infections. Blood cultures secured under aseptic conditions as previously described and blood smears obtained from the jugular vein during the early stages of the acute attack of anaplasmosis on these yearlings failed to reveal the presence of *Pasteurella.*

Both animals died during the nights of the 13th and 15th days, respectively, following the anaplasma inoculation. Autopsies were held the following mornings. Postmortem lesions typical of acute anaplasmosis were observed in both animals. The skin, visible mucous membranes and subcutaneous connective tissue presented a yellowish discoloration. The blood and muscle tissues were pale. The pericardium and epicardium were flecked with petechial hemorrhages. Extensive subendocardial hemorrhages were present. The lungs presented areas of congestion and the mediastinal lymph glands were edematous. There were prominent subcortical petechial hemorrhages of the kidneys. The liver was congested and the gall bladder distended with dark, thick bile. Catarrhal enteritis and evidence of intestinal hemorrhage were present.

The hearts were removed by ligating and severing the large blood vessels. Cultures of the heart blood were made and incubated at 37.5° C. Samples of the heart blood were collected in sterile tubes and held at room temperature for observation. *P. boviseptica* was isolated from the heart blood of these two yearlings which died as a result of acute anaplasmosis.

CHRONIC ANAPLASMOSIS AND *P. boviseptica*

Experiment 4: Observations having been made on animals harboring *P. boviseptica* in the respiratory passage during acute infections of *A. marginale,* it was desired to observe the action of these agents in cattle suffering from chronic infections of anaplasmosis. During May 1935 calves H 125 and H 151 were exposed to *Pasteurella* by means of a nasal spray. At this time these animals were given intravenous injections of 15 and 30 cc., respectively, of citrated blood representing three strains of bovine anaplasmosis. These animals reacted after the 18th day to a mild form of anaplasmosis. Clinical symptoms of anaplasmosis were present for 10 days. After this the animals were perfectly normal in outward appearance. Splenectomies were then perfomed, after which a state of chronic anaplasma infection ensued. During the chronic attack over 50 percent of the erythrocytes were parasitized by *A. marginale* and the hemoglobin content of the blood varied from 4 to 8 grams per 100 cc. (Dare) during the period. Frequent blood cultures, stained blood smears, and rabbit inoculations of blood from the affected animals during the period of chronic infection failed to show the presence of *Pasteurella* organisms.

Frequent examinations of the bacterial flora of nasal secretions during the experiment showed the presence of *P. boviseptica.* Bull calf H 125 died from the induced attack of chronic anaplasmosis after a period of four months. Cultures taken from the heart blood a few hours after death showed the presence of *P. boviseptica.* Bull calf H 151 was killed in an advanced stage of chronic anaplasmosis of two months duration. Cultures of the heart blood failed to reveal the presence of *Pasteurella.* There was no evidence of *P. boviseptica* entering the blood stream of these test animals as a result of clinical *A. marginale* infection.

Results of Experiments 3 and 4 led to the conclusion that *P. boviseptica* inhabiting the respiratory passage of cattle appear in the blood shortly after death as a postmortem invader incident to *A. marginale* infection. It was also evident that *P. boviseptica* inhabiting the upper respiratory tract did not establish clinical hemorrhagic septicemia in animals affected with acute or chronic anaplasmosis.

SHIPPING FEVER AND *P. boviseptica*

Experiment 5: During September 1935 opportunity was afforded for making clinical and postmortem observations in a herd of 60 dairy cows exhibiting clinical symptoms of catarrhal pneumonia and interstitial pulmonary emphysema following transportation by railway cars. The animals were purchased in a nearby state and showed evidence of being in poor physical condition before shipping. A number were held in shipping pens for several days at the point of origin until the consignment could be completed and dispatched to the destination point in Florida. Upon arrival at their destination, 12 animals were visibly affected, exhibiting emaciation, nasal discharge, cough, increased temperature and pulse, and dyspnea. A few were showing evidence of subcutaneous emphysema. During the four days following arrival 13 additional animals included in this shipment developed similar, though milder, clinical symptoms. Eight animals in various stages of this condition were selected for the purpose of taking blood cultures. Various quantities of blood were drawn under aseptic conditions into flasks containing Kracke and Teasley's blood culture media and incubated at 37.5° C. Other blood samples were collected in sterile test tubes and held at room temperature for observations.

By these cultural methods *Pasteurella* and colon type organisms were isolated from the blood stream of one animal six hours before death. Blood cultures from a second animal yielded *P. boviseptica* and a gram-negative rod which did not ferment any of the sugars employed. Cultures from a third animal secured eight hours before death yielded *P. boviseptica* alone. Postmortem observations made on these three animals shortly after death revealed a catarrhal bronchopneumonia and interstitial pulmonary emphysema. Samples of heart blood from these animals secured at autopsy revealed the presence of *Pasteurella* and colon type organisms. The *Pasteurella* were pathogenic for rabbits in quantities of 0.001 cc. of an 18-hour bouillon culture when given intraperitoneally. Neither *Pasteurella* nor any other organism could be cultured from the blood of five animals during early stages of shipping fever. No effort was made by the owner to isolate the clinical cases of shipping fever. The sick and well animals included in this shipment drank from a common trough and intermixed freely with the native cows without further spread of the disease.

Results of Experiment 5 show that *P. boviseptica* and other microorganisms may appear in the blood stream of cattle shortly before death from pulmonary emphysema and pneumonia which occurred incident to shipping.

ENZOOTIC PNEUMONIA AND *P. boviseptica*

During the past several years opportunity has been afforded for observing a malignant condition among dairy calves and yearlings which corresponds in its clinical, postmortem and bacteriological manifestations and occurrence to enzootic, septic or bronchopneumonia of young animals as reported by Hutyra and Marek *(4)*. The condition as encountered in Florida occurred frequently in suckling calves and yearlings. In several of the affected herds the mortality rate amounted to 70 percent of the annual calf crop. Further economic loss was sustained since recovered animals were underdeveloped, unthrifty and unprofitable. When the condition is first introduced into a herd it begins among the young calves as an acute infection of the gastrointestinal tract. The first symptoms to develop consist of loss of appetite, unthriftiness and acute diarrhea. More advanced cases develop a mucopurulent nasal discharge, swelling of the sublingual region, cough, depression, blood flecked droppings and labored respirations. Temporary improvement may be followed by a more prolonged and serious attack of a chronic nature. Symptoms of the chronic form are cough, unthriftiness, labored respirations and mucopurulent nasal discharge. Affected animals usually assume a characteristic position of sternal recumbency, extension of head and neck, and resting of cervical and mandibular regions on the ground. The mouth is often held partially open, in which instance the tongue is protruded and very labored respirations are present. (See Fig. 1.) Affected animals may linger for several weeks, becoming gradually emaciated, and finally die with symptoms of pneumonia and pulmonary edema. Postmortem examinations made during various stages of chronic cases showed a progressive bilateral solidification of the lung tissue. The disease process begins in the lower apical lobe and extends to involve the cardiac and diaphragmatic lobes. Fatal cases show involvement of the entire lungs with the exception of very small portions of the dorsal border of the diaphragmatic lobes. Due to economic loss, resulting from year to year in the calf crop, studies were undertaken regarding the nature and transmission of enzootic pneumonia.

P. boviseptica was the predominating bacterial species isolated from the diseased lung tissue of those cases showing advanced lesions of pneumonia. The virulence of these organisms for small laboratory animals was typical of the *Pasteurella* group. Affected lungs from chronic cases of enzootic pneumonia may reveal the presence of *Staphylococcus* and species of *Penicillium*. The colon organism, *Escherichia coli,* which produced severe enteritis in healthy calves was isolated from the intestinal canal and droppings of acute cases. Microscopic examinations of fecal samples from young calves affected with enzootic pneumonia showed the presence of species of coccidia and nematode ova. Examinations of feces of older calves suffering from a chronic form of enzootic pneumonia revealed heavy nematode infestations. Postmortem examinations of yearlings which survived an acute attack of enzootic pneumonia often showed presence of the following parasites: hookworm, *Bunostomum phlebotomum;* tapeworm, *Moniezia benedeni;* nodular worm, *Oesophagostomum radiatum;* stomach worm, *Haemonchus contortus;* whipworm, *Trichuris ovis;* lungworm, *Dictyocaulus viviparus;* and thread-like worm, *Setaria labiato-papillosa.* Affected calves often were infested with the sucking louse, *Linognathus vituli.*

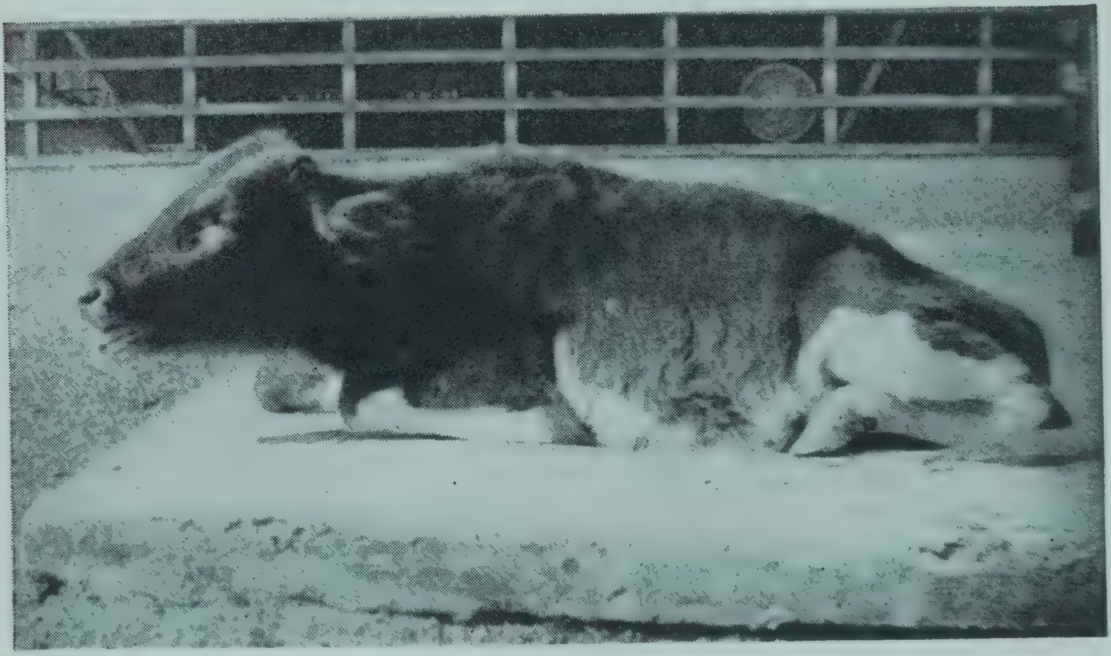

Fig. 1.—Enzootic bronchopneumonia. Note sternal recumbency, extended head and neck, drooped ears, oral breathing and protruded tongue.

Experiment 6: Attempts were made to transmit enzootic pneumonia in calves by contact. Eight calves in various stages of the disease were selected from naturally occurring field cases and confined with a similar number of young healthy calves in the isolation pens previously described. Although diarrhea typical of early stages of the disease developed in the calves thus exposed, typical enzootic pneumonia as observed under field conditions did not develop. Nasal and bronchial secretions of calves affected with enzootic pneumonia, minced portions of affected lung tissue containing numerous *Pasteurella* and bacterial-free filtrates of these materials did not reproduce the disease when healthy calves were exposed thereto by nasal sprays and drenches.

It was concluded from this experiment that predisposing factors, not present in the isolation pens but incident to environment of affected premises, were necessary for successful transmission of enzootic pneumonia.

FIELD STUDIES OF ENZOOTIC PNEUMONIA AND *P. boviseptica*

Experiment 7: Further attempts were made to determine the predisposing factors that influenced susceptibility of calves to enzootic pneumonia as observed under field conditions. Young healthy calves three to four days of age were secured from herds not affected with the disease. They were confined and reared on a small lot heavily contaminated with droppings of animals showing clinical manifestations of the acute and chronic types of enzootic pneumonia. Typical acute and chronic enzootic pneumonia as observed in natural outbreaks subsequently developed in a number of the test calves. Postmortem examinations of such reproduced cases showed lesions typical of those occurring under natural conditions. *P. boviseptica* was the predominating bacterial species isolated from affected lungs of the cases occurring under experimental conditions.

Results of Experiment 7 show that predisposing factors incident to crowded, unsanitary, permanent calf lots were necessary to reproduce typical cases of pneumonia in calves.

Crotalaria spectabilis POISONING AND *P. boviseptica*

Experiment 8: Postmortem lesions in cattle consisting of hemorrhages and gastrointestinal edema were observed by workers at the Florida Agricultural Experiment Station *(2, 11, 14)* in cattle poisoned by *Crotalaria spectabilis.* Since these lesions may be suspected of having a septicemic origin, it seemed desirable to ascertain if *P. boviseptica* could be demonstrated in the blood of animals which had died of crotalaria poisoning. Three pounds of *C. spectabilis* seed were covered with a menstrum of ammoniated water in a suitable container fitted with a lid. The mixture was stirred occasionally and allowed to macerate for several days. At three-day intervals 200 cc. of menstrum was decanted and the original volume restored by adding fresh ammoniated water. As the menstrum was decanted it was administered as a drench to a 300-pound bull calf. The animal had previously been exposed to *P. boviseptica* by nasal spray. Symptoms of crotalaria poisoning developed in two weeks following the first drench and no further menstrum was given. The bull died on the 29th day following the initial feeding. Cultures of the blood secured four hours before death did not show the presence of organisms. Postmortem examination a few hours after death showed petechial hemorrhages of the viscera and serous membranes, severe gastroenteritis and edema. Samples of blood secured at autopsy revealed the presence of *Pasteurella*. In this case, organisms were more numerous within the leucocytes in those blood vessels situated nearest the laryngopharyngeal region. These organisms were highly virulent for rabbits as proven by introperitoneal inoculations.

It was concluded from this experiment that *P. boviseptica* inhabiting the upper respiratory passage of cattle gain entrance to the blood stream and multiply rapidly after death from *C. spectabilis* poisoning.

OMPHALOPHLEBITIS OF CALVES AND *P. boviseptica*

Experiment 9: *Pasteurella* has been demonstrated as the causative agent in some cases of omphalophlebitis of suckling calves *(4)*. Tests were run to determine if the organisms encountered in these investigations were capable of initiating symptoms and lesions of this condition. Six calves under 48 hours of age were secured from a herd where omphalophlebitis had not been known to occur. These calves were given umbilical injections using 2 to 3 cc. of saline suspensions of various strains and densities of *P. boviseptica*. Following the injections there occurred depression, inappetance, elevation of temperature, blood flecked foamy fetid diarrhea, straining and emaciation with occasional involvement of one or more joints. These symptoms were manifest over a period of several weeks, resulting in underdevelopment of the calves. Pronounced symptoms of bronchopneumonia developed in four of these calves about the 60th day following the umbilical injections.

Results of Experiment 9 show that strains of *P. boviseptica* used in the investigations of hemorrhagic septicemia were representative of the group in so far as their ability to produce navel infections was concerned.

VIRULENCY OF *P. boviseptica* FOR THE CROW

Experiment 10: The purpose of this experiment was to determine if the crow, *Corvus ossifragus,* was susceptible to *P. boviseptica* infection and capable of disseminating these organisms. Twenty-two live specimens were trapped in a field and transferred to the isolation pens where they were confined in wire cages. After being held 10 days for observation, 0.1 cc. of a 24-hour bouillon culture of *Pasteurella,* isolated from the bronchial secretion of an apparently healthy cow, was instilled into the right eye and nasal cleft of six crows. Fourteen hours later three of the inoculated crows were dead, and the other three were visibly sick. Forty-eight hours later one uninoculated crow died. Several crows lived in the pen for a period of 66 days exhibiting symptoms of chronic *Pasteurella* infection. *Pasteurella* was isolated from the blood stream of those birds exhibiting acute and subacute types of infections. This organism was isolated from the posterior nares of the chronically affected birds at intervals during the experiment and from their blood stream a few hours before death.

Postmortem lesions observed in these crows consisted of hemorrhagic laryngotracheitis, hemorrhagic enteritis, congested lungs, parenchymatous degeneration of the liver, spleen and kidneys, petechiae of the pericardium and increased pericardial fluid.

Results of Experiment 10 show that the crow, *C. ossifragus,* is susceptible to *P. boviseptica* infection and strongly suggests a possibility of it serving to disseminate *Pasteurella* organisms in nature.

DISCUSSION

On the basis of these studies the virulency of *Pasteurella* organisms for cattle cannot be compared to that found by workers regarding this group of organisms for chickens and rabbits. Under the conditions of the experiments it was impossible to produce cases of hemorrhagic septicemia by exposing cattle to *P. boviseptica.* This organism constitutes part of the bacterial flora which is abundant in the upper respiratory passage and general environment of apparently normal healthy cattle. It is realized that different degrees of virulence have been attributed to strains of *Pasteurella* under variable conditions. Since the organisms used in these studies were isolated from cattle tissues and were highly virulent for rabbits it was concluded that they were representative of the group. No evaluation is claimed for organisms other than those encountered and examined in these studies, or for their action on animals under climatic or environmental conditions other than those undertaken in the investigations.

The observations regarding shipping fever of cattle indicate that lowering of vitality incident to railway transportation is a serious predisposing factor bringing about invasion of the blood stream by *Pasteurella* and other organisms. Cattle that have died as a result of anaplasmosis, pseudorabies, plant poisoning or other conditions often reveal *P. boviseptica* in the blood or tissues. The presence of *P. boviseptica* in bovine carcass material under these conditions often leads to an error in making a diagnosis. The organisms usually enter the blood stream of cattle shortly before or after death and multiply rapidly.

In the diagnosis of hemorrhagic septicemia of cattle, conclusions often are drawn from clinical symptoms alone. In other instances the diagnosis is confirmed in the laboratory by demonstrating bipolar organisms resembling *Pasteurella* in tissues of suspicious materials. The diagnosis often is confirmed by recovery of *P. boviseptica* from rabbits which receive injections of materials from suspected hemorrhagic septicemia tissues.

In the light of the present experimental evidence, *P. boviseptica* occurring in suspicious hemorrhagic septicemia tissues of cattle cannot be credited as having any special etiological significance in this section.

In regard to navel infections which were produced by strains of *P. boviseptica* it might be stated that various species of microorganisms present in the environment of cattle are capable of causing navel infections in calves. *P. boviseptica* is no exception to this rule.

It seems safe to state that *Pasteurella* organisms associated with the inflammatory process of the lung in enzootic pneumonia do not exert pathogenic action alone. These studies show their action is dependent upon pre-disposing factors enumerated and that environmental conditions present on the affected premises lower body resistance sufficiently to permit microorganisms colonizing in the respiratory passage to exert a pathogenic action under such influence. Enzootic pneumonia has not been observed on premises where strict sanitary methods of rearing calves are practiced. The incidence of enzootic pneumonia as observed under natural farm conditions has been reduced in direct proportion to hygienic methods employed in rearing calves.

SUMMARY

P. boviseptica is frequently encountered at autopsy in the blood and internal organs of Florida cattle.

Exposure of cattle to *P. boviseptica* by ingestion and nasal spray failed to produce septicemia. The organism was recovered from the nasopharynx of cattle, showing no gross lesions, three months following such exposure.

P. boviseptica was demonstrated in the tracheal exudate of cattle that died from infection with the filterable virus of pseudorabies. The organism was also demonstrated in the blood and internal organs shortly after death due to *Anaplasma marginale* infection and *Crotalaria spectabilis* poisoning. *P. boviseptica,* colon type and other saprophytic organisms frequently may be isolated from the blood stream of cattle showing advanced symptoms of bronchopneumonia and pulmonary emphysema which develop incident to railway transportation.

P. boviseptica was the predominating bacterial species isolated from diseased lungs of calves affected with enzootic pneumonia. The microorganism colonizes in the respiratory passage of young calves and exerts pathogenic action under influences of predisposing factors prevalent on affected premises. This type of pneumonia may be controlled by employing sanitary methods of rearing calves.

P. boviseptica produced acute and chronic pasteurellosis in the fish crow, *Corvus ossifragus,* when the organisms were instilled into the nasal cleft.

All strains of *P. boviseptica* employed in these investigations were lethal for rabbits in amounts of 0.001 cc. of a 24-hour bouillon culture when injected intraperitoneally.

In the light of present experimental evidence, *P. boviseptica* occurring in carcass material of cattle cannot be credited as having any special etiological significance in this section.

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UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
GAINESVILLE, FLORIDA
WILMON NEWELL, Director

TESTS OF CIGAR-WRAPPER TOBACCO VARIETIES RESISTANT TO BLACKSHANK

By

L. O. GRATZ and RANDALL R. KINCAID

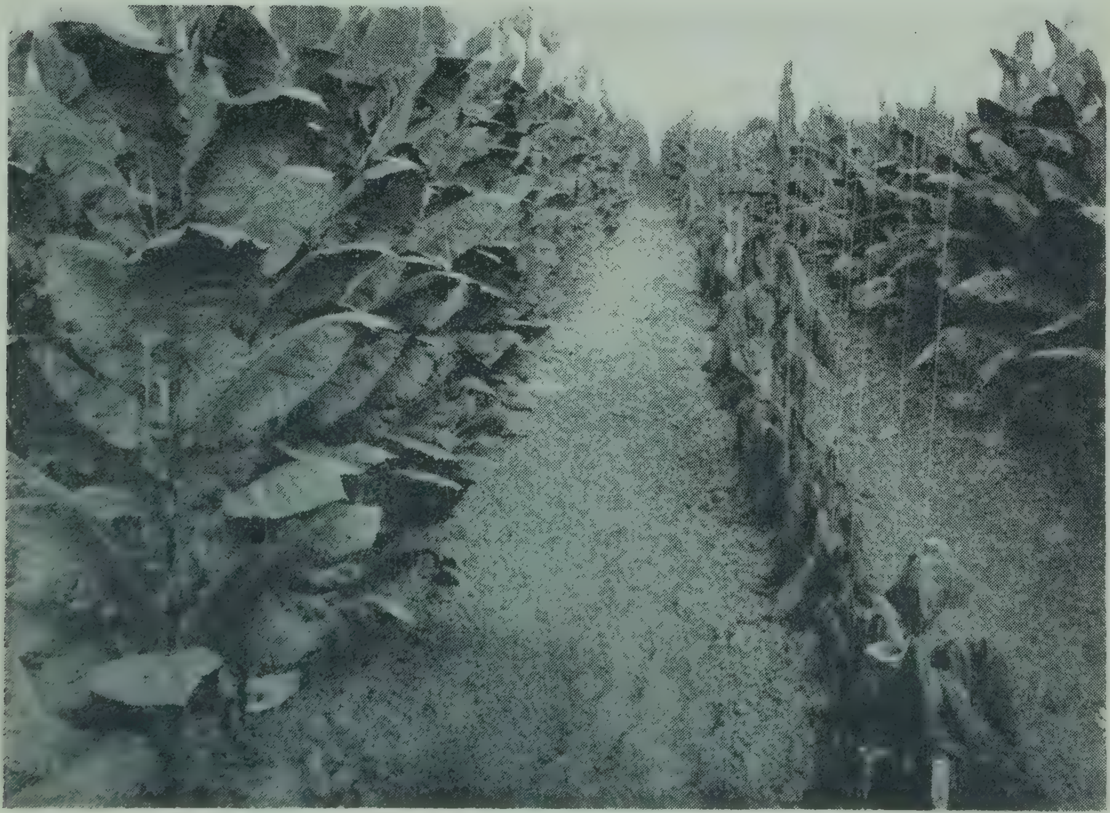

Fig. 1.—A blackshank-resistant variety of tobacco developed at the North Florida Experiment Station, and the susceptible Connecticut Round Tip variety.

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TESTS OF CIGAR-WRAPPER TOBACCO VARIETIES RESISTANT TO BLACKSHANK

By L. O. GRATZ and RANDALL R. KINCAID

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INTRODUCTION

The blackshank situation in the cigar-wrapper industry in Florida from 1920 to 1930 was clearly defined by Tisdale (*1*), *2*, *3*), and a brief review will suffice here. Blackshank, caused by *Phytophthora nicotianae* Breda de Haan (*P. parasitica* var. *nicotianae* Tucker), was first observed near Fowlstown, Georgia, about 1915. It spread throughout the district and was identified by Tisdale in 1922. For about 10 years after that it was the most serious disease in the Southern cigar-wrapper area. It was found that under the conditions in which shade-grown cigar-wrapper tobacco is produced, blackshank could be controlled only by planting resistant varieties. Tisdale's success in developing varieties satisfactory for both resistance and quality was outstanding.

Several varieties produced by breeding and selection showed much promise from the standpoint of yield, quality and resistance to this disease. These were designated R, 301, 94 and Rg. R was a suspected cross between the susceptible Connecticut Round Tip variety and a partially resistant strain of the Big Cuba variety. Variety 301 was a cross between Big Cuba and the highly resistant Little Cuba variety. Variety 94 was a cross between 301 and R, two selections of which are subsequently designated as 94-2 and 94-4. The Rg variety was

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Acknowledgment.—The authors wish to acknowledge the services of Jesse Reeves, Farm Superintendent, under whose immediate direction all of the work of growing and curing, sweating and grading, as well as the manufacture of the cigars, was carried on.

the progeny of a single surviving plant in a row of Connecticut Round Tip grown in 1929. Repeated attempts to obtain blackshank resistance in Connecticut Round Tip by selection have been unsuccessful. Furthermore, the Rg variety resembled certain hybrid varieties more closely than Connecticut Round Tip. Therefore, it is believed that the original resistant Rg plant resulted from a hybrid seed accidentally introduced into the seedbed of the Connecticut Round Tip variety.

Because of the urgent demand for blackshank-resistant varieties for commercial production, several of those produced by Tisdale were released to growers before their comparative value for wrappers had been determined. By 1932 these varieties were grown on a considerable acreage but during recent years Rg has been planted most extensively by growers in the Southern wrapper-producing area. Because of complications arising from the use of several varieties in a comparatively small area the need arose for tests of some of the most promising, to determine their resistance, quality and other characteristics under comparable conditions, so that the least desirable ones might be eliminated from commercial production. Results of these tests are reported in this bulletin.

Seed of blackshank-resistant varieties are produced at the North Florida Experiment Station for growers of cigar-wrapper tobacco. Also a program of breeding and selection is being continued at this station in the hope of developing disease-resistant varieties that may prove still more desirable in yield and quality. Since those now being grown commercially are reasonably satisfactory to growers, packers and cigar manufacturers, tests of new varieties will be continued until their superiority is thoroughly demonstrated before any are released to growers.

METHODS

Five varieties, 301, 94-2, 94-4, R and Rg, were planted, each in three 1/15 acre plots totaling 1/5 acre of each variety. Thus the entire experiment covered one acre, and provided a sufficient volume of tobacco for the observations desired. The soil was heavily infested with the blackshank fungus and root-knot nematodes *(Heterodera marioni* Goodey). Observations were made in the field on blackshank and root-knot infection, and also on the general growth habit of the plants and other plant characteristics. Local growers and packers were invited to study the different varieties and to give their opinions of them.

Second, third and fourth primings only were harvested for further observations, because of lack of barn space. These primings were cured, sweated and graded in the usual commercial manner. Corresponding primings from the three replications were combined to give sufficient volume for commercial grading. Samples of certain grades were used in tests on cigars. Throughout the season every precaution was taken to give all varieties comparable treatment.

This procedure was followed for four years, 1933 to 1936, inclusive, except that the R variety was discontinued after the second year because it offered no promise with respect to yield and quality.

RESULTS

BLACKSHANK AND ROOT-KNOT

Blackshank infection as indicated by the number of plants wilted and dead was determined at intervals of about 10 days throughout the growing season. Rows of Connecticut Round Tip planted near the resistant varieties and under identical conditions served as checks. Results of the final inspections, made each year during the harvest season in June, are given in Table 1.

TABLE 1.—PERCENTAGES OF TOBACCO PLANTS WILTED AND DEAD BECAUSE OF BLACKSHANK FROM 1933 TO 1936, INCLUSIVE.

Year	Variety					
	RT	301	94-2	94-4	R	Rg
1933	25	0	1	0	0	0
1934	64	2	2	0	2	2
1935	67	3	5	7		2
1936	95	15	25	37		6
Average	62.75	5.0	8.25	11.0		2.5

At the end of each priming season except the first a sample of about 500 plants of each variety was pulled and the roots were examined for blackshank and root-knot. The plants of each variety were classified according to the severity of blackshank and root-knot infection, and percentage values were assigned to each classification. The classifications for blackshank were as follows: None (0%), trace (10%), slight (20%), medium (40%), severe (70%), and dead (100%); those for root-knot were: None (0%), trace (10%), slight (20%), medium (60%), and severe (100%). The calculated average severity of infection was used as an index for comparing the different varieties in each year. This calculated index for the four different varieties, given in Table 2, should not be confused with the actual percentage of plants wilted and dead, given in Table 1.

TABLE 2.—CALCULATED AVERAGE SEVERITY OF BLACKSHANK AND OF ROOT-KNOT ON THE ROOTS OF TOBACCO VARIETIES IN 1934, 1935 AND 1936.

Year	Blackshank				Root-Knot			
	301	94-2	94-4	Rg	301	94-2	94-4	Rg
1934	8	17	6	5	24	33	38	44
1935	14	18	15	5	28	33	23	24
1936	38	53	54	22	45	47	43	66
Average	20	29	25	11	32	38	34	45

Results given in both Tables 1 and 2 show that these four resistant varieties suffered a much smaller amount of blackshank infection than the checks of the Connecticut Round Tip variety; Rg being most resistant, followed by 301. In comparison with the resistant varieties Connecticut Round Tip check rows were heavily infected by the end of each priming season and no severity index is given for this variety.

Average losses from blackshank varied widely during the four years of the test, being largest in 1936. The percentage of plants severely infected, as indicated by wilting, remained fairly small for Rg. The low percentages of blackshank during the first three years of the experiment cannot be explained, but it is to be observed that both the susceptible Connecticut Round Tip and the four resistant varieties followed the same general trend during the four years of the trial.

Average severity of root-knot infection was rather high in all varieties, indicating that all are about equally susceptible.

DATE OF BLOOMING AND PRIMING

The stage of buttoning or blooming is one of the characters commonly considered by growers in judging the ripeness of a crop for the first priming. To check the applicability of this method to the varieties under test, comparative observations were made in 1933. The number of plants in bloom on three different dates was used in calculating the date on which approximately 10% of the plants were in bloom. This date, together with the percentage of plants in bloom on June 14, and dates of harvesting of the second, third and fourth primings are given in Table 3.

TABLE 3.—DATES OF BLOOMING AND OF PRIMING OF DIFFERENT VARIETIES IN 1933.

Variety	Plants in bloom June 14	Date of blooming*	Date of priming middles		
			Second	Third	Fourth
	%	June	June	June	June
301	8	15	15	22	30
94-2	4	16	15	22	30
94-4	12	13	14	20	29
R	21	12	16	26	1**
Rg	0	17	14	20	29
Conn. R. T.	10	14	—	—	—

*10% of plants.
**July.

It is interesting to note that the Rg variety, which was latest in blooming, was judged by other methods as one of the earliest in ripeness for priming, and that the reverse was true for R. It is evident that there is a difference of several days among the five resistant varieties in the stage of blooming at the date of the second priming, and that the judging of ripeness by the stage of buttoning must be adapted to each variety.

OTHER PLANT CHARACTERISTICS

Although all five resistant varieties were judged satisfactory from the standpoint of growth characteristics, certain observations should be mentioned.

The color of the leaves in the field varied considerably. R was the darkest green, followed in order by 301, 94-2, 94-4 and Rg. This order was approximately the same as that for date of priming from latest to earliest.

The angle at which the leaves are joined to the stalk was widest for 301, the leaves hanging approximately at right angles to the stalk. The angle decreased for other varieties in the following order: 94-2, Rg, 94-4, and R. This angle is of practical importance because leaves which hang lowest are most subject first, to damage during cultivation, and second, to turning in the wind, which makes it necessary to turn them back before the lower surfaces are scalded by strong sunlight. Also, among the four resistant varieties, 94-2 was most damaged by storms of wind and rain, the stalks becoming crooked and the leaves turned and twisted; Rg was next in order followed by 94-4 and 301.

The angle which the lateral veins made with the midrib (called the stem by the trade) of the leaf differed slightly. In 301 it was approximately 90° or a right angle near the base of the leaf. Rg was almost the same, and 94-2, 94-4 and R had slightly acute angles. Acute angles are considered desirable by cigar manufacturers, but the differences among the five resistant varieties in this respect were not considerable.

Measurements of leaves of the second, third and fourth primings were made in 1933. Of three width measurements of the leaf, the first was taken half way between the middle and the tip, the second at the middle, and third half way between the middle and the base. These are designated as the measurements of the tip, middle and base, respectively. Approximately 100 leaves of each priming were selected at random and measured immediately after harvesting. The same leaves were measured again after curing and sweating, only the length and middle width being taken. Average measurements for the three primings, representing 300 leaves of each variety, are given in Table 4.

TABLE 4.—AVERAGE MEASUREMENTS IN INCHES OF GREEN AND CURED LEAVES FROM DIFFERENT VARIETIES IN 1933.

Variety	Primings	Green leaves				Cured leaves	
		Length	Width			Length	Middle width
			Tip	Middle	Base		
301	2, 3, 4	22.2	9.5	13.0	10.7	19.1	10.1
94-2	2, 3, 4	22.7	10.1	12.9	9.9	20.2	10.5
94-4	2, 3, 4	21.6	9.6	12.3	9.2	19.4	10.4
R	2, 3, 4	21.7	9.8	13.0	10.6	19.1	10.8
Rg	2, 3, 4	22.5	10.5	13.4	10.6	20.2	11.2

These measurements show that the leaves of the five resistant varieties were very similar in size and shape. The shape of the leaf probably affected to a certain extent the yield of cigar wrappers per leaf, as reported later in this bulletin.

NUMBER OF POUNDS HARVESTED

Yields of the varieties tested were determined for only the second, third and fourth primings. Yields of these three primings, calculated on a basis of one acre, are given in Table 5.

Although total yields of all primings were not determined it is believed that the partial yields given are a fairly reliable indication. R was lowest in yield for both years in which it was included in the test. Among the other four varieties 94-4 was lowest for three years out of four. Rg, 301 and 94-2 averaged nearly the same for the four years of the test.

TABLE 5.—Number of Pounds of Graded Tobacco Harvested per Acre from the Second, Third and Fourth Primings of the Different Varieties of Wrapper Tobacco.

Year	301	94-2	94-4	R	Rg
1933	629	603	549	429	640
1934	630	671	669	593	620
1935	645	613	588	......	643
1936	562	499	392	......	590
Average	617	597	550	......	623

GRADES AND RELATIVE VALUES

After curing and sweating the experimental lots were graded in the usual commercial manner. Samples of the different grades were submitted each year except one to several packers, who placed an estimated valuation on the tobacco represented. The average of these estimates for each grade was used in calculating the value of the crop for that year. The 1933 scale of values was used also in 1934.

Since there was some variation in the number of pounds harvested, all data obtained when the tobacco was graded were calculated on a basis of 100 pounds from the three primings of each variety. These data are presented in Tables 6 to 10, inclusive.

TABLE 6.—GRADES AND VALUES PER 100 POUNDS OF THE SECOND, THIRD AND FOURTH PRIMINGS PRODUCED BY FIVE RESISTANT VARIETIES OF WRAPPER TOBACCO IN 1933.

Grades	Assigned value per pound	301		94-2		94-4		R		Rg	
		pounds	value	pounds	value	pounds	value	pounds	value	pounds	value
Prime light	$1.90	0.5	$ .95	2.0	$ 3.80	1.2	$ 2.28	0.1	$ .19	2.7	$ 5.13
Fleshy light	1.50	1.7	2.55	6.2	9.30	3.5	5.25	1.2	1.80	4.9	7.35
Medium light	1.00	14.8	14.80	11.5	11.50	16.0	16.00	10.2	10.20	15.2	15.20
Off color	1.20	7.3	8.76	3.8	4.56	3.8	4.56	5.9	7.08	3.0	3.60
Stained	.70	1.3	.91	4.9	3.43	1.0	.70	3.7	2.59	1.1	.77
Heavy medium	.60	21.3	12.78	9.6	5.76	16.0	9.60	23.4	14.04	17.9	10.74
No. 2 off color		0	0	0	0	0	0	0	0	0	0
White vein	.90	22.0	19.80	30.5	27.45	30.9	27.81	30.1	27.09	25.9	23.31
No. 2 light	1.00	2.2	2.20	4.8	4.80	2.6	2.60	1.0	1.00	3.9	3.90
Broke light	.60	1.5	.90	1.3	.78	1.9	1.14	1.0	.60	1.9	1.14
Broke medium	.40	14.6	5.84	10.8	4.32	10.8	4.32	10.4	4.16	10.8	4.32
Broke white vein	.40	6.5	2.60	8.4	3.36	7.0	2.80	5.4	2.16	7.2	2.88
Filler	.10	6.3	.63	6.2	.62	5.3	.53	7.6	.76	5.5	.55
Totals		100.0	72.72	100.0	79.68	100.0	77.59	100.0	71.67	100.0	78.89
Increase over 301—Cash value					6.96		4.87		-1.05		6.17
Percent				9.57		6.70		-1.44		8.48	

TABLE 7.—GRADES AND VALUES PER 100 POUNDS OF THE SECOND, THIRD AND FOURTH PRIMINGS PRODUCED BY FIVE RESISTANT VARIETIES OF WRAPPER TOBACCO IN 1934.

Grades	Assigned value per pound	301		94-2		94-4		R		Rg	
		pounds	value	pounds	value	pounds	value	pounds	value	pounds	value
Prime light	$1.90	0.8	$ 1.52	1.0	$ 1.90	1.5	$ 2.85	0.1	$ .19	1.8	$ 3.42
Fleshy light	1.50	0.6	.90	1.7	2.55	2.4	3.60	0.3	.45	1.5	2.25
Medium light	1.00	2.9	2.90	5.7	5.70	7.9	7.90	3.1	3.10	6.1	6.10
Off color	1.20	18.6	22.32	13.2	15.84	21.5	25.80	7.2	8.64	17.0	20.40
Stained	.70	0.2	.14	4.6	3.22	1.1	.77	0.7	.49	1.6	1.12
Heavy medium	.60	8.7	5.22	8.5	5.10	13.5	8.10	8.2	4.92	9.5	5.70
No. 2 off color	.60	20.6	12.36	6.7	4.02	9.0	5.40	15.6	9.36	11.9	7.14
White vein	.90	2.8	2.52	4.6	4.14	6.2	5.58	6.0	5.40	4.3	3.87
No. 2 light	1.00	12.7	12.70	22.2	22.20	16.5	16.50	9.4	9.40	20.3	20.30
Broke light	.60	14.4	8.64	12.8	7.68	7.4	4.44	10.1	6.06	9.8	5.88
Broke medium	.40	7.3	2.92	8.8	3.52	7.4	2.96	14.7	5.88	8.3	3.32
Broke white vein	.40	0.9	.36	1.3	.52	1.8	.72	2.6	1.04	1.5	.60
Filler	.10	9.5	.95	8.8	.88	3.8	.38	22.0	2.20	6.4	.64
Totals		100.0	73.45	100.0	77.27	100.0	85.00	100.0	57.13	100.0	80.74
Increase over 301—Cash value					3.82		11.55		–16.32		7.29
Percent				5.20		15.72		–22.22		9.92	

TABLE 8.—GRADES AND VALUES PER 100 POUNDS OF THE SECOND, THIRD AND FOURTH PRIMINGS PRODUCED BY FOUR RESISTANT VARIETIES OF WRAPPER TOBACCO IN 1935.

Grades	Assigned value per pound	301		94-2		94-4		Rg	
		pounds	value	pounds	value	pounds	value	pounds	value
Prime light	$1.40	0.3	$ .42	0.6	$ .84	0.7	$ .98	1.1	$ 1.54
Fleshy light	1.30	1.0	1.30	1.3	1.69	1.9	2.47	2.3	2.99
Medium light	.90	4.2	3.78	5.4	4.86	7.0	6.30	6.0	5.40
Off color	1.10	10.3	11.33	9.6	10.56	14.0	15.40	18.8	20.68
Stained	.70	6.2	4.34	18.6	13.02	11.0	7.70	5.4	3.78
Heavy medium	.70	14.6	10.22	12.7	8.89	18.5	12.95	16.6	11.62
No. 2 off color	.70	35.6	24.92	13.8	9.66	20.0	14.00	21.4	14.98
White vein	.90	0	0	0.2	.18	0	0	0.1	.09
No. 2 light	.90	6.0	5.40	10.3	9.27	7.2	6.48	9.5	8.55
Broke light	.60	8.2	4.92	5.6	3.36	4.5	2.70	5.2	3.12
Broke medium	.50	6.6	3.30	13.3	6.65	8.0	4.00	9.3	4.65
Broke white vein	.40	0	0	0	0	0	0	0	0
Filler	.10	7.0	.70	8.6	.86	7.2	.72	4.3	.43
Totals		100.0	70.63	100.0	69.84	100.0	73.70	100.0	77.83
Increase over 301—Cash value					–.79		3.07		7.20
Percent					–1.12		4.35		10.19

TABLE 9.—GRADES AND VALUES PER 100 POUNDS OF THE SECOND, THIRD AND FOURTH PRIMINGS PRODUCED BY FOUR RESISTANT VARIETIES OF WRAPPER TOBACCO IN 1936.

Grades	Assigned value per pound	301		94-2		94-4		Rg	
		pounds	value	pounds	value	pounds	value	pounds	value
Prime light	$1.50	0.3	$ .45	0.4	$ .60	0.5	$ .75	0.5	$ .75
Fleshy light	1.25	0.2	.25	0.6	.75	0.4	.50	0.4	.50
Medium light	1.10	2.1	2.31	3.4	3.74	3.9	4.29	2.4	2.64
Off color	1.10	16.5	18.15	17.5	19.25	17.0	18.70	22.0	24.20
Stained	.55	3.9	2.15	15.3	8.42	15.1	8.31	7.3	4.02
Heavy medium	.65	6.3	4.10	5.7	3.71	9.6	6.24	6.6	4.29
No. 2 off color	.70	33.5	23.45	13.3	9.31	18.6	13.02	14.9	10.43
White vein	.90	1.0	.90	0.2	.18	0.2	.18	2.4	2.16
No. 2 light	1.00	11.9	11.90	16.3	16.30	10.8	10.80	17.3	17.30
Broke light	.65	13.1	8.52	13.6	8.84	10.6	6.89	14.6	9.49
Broke medium	.50	5.1	2.55	7.2	3.60	5.2	2.60	5.5	2.75
Broke white vein	.40	0.2	.08	0.1	.04	0		0.5	.20
Filler	.10	5.9	.59	6.4	.64	8.1	.81	5.6	.56
Totals		100.0	75.40	100.0	75.38	100.0	73.09	100.0	79.29
Increase over 301—In cash					−.02		−2.31		3.89
Percent				−.03		−3.06		5.16	

TABLE 10.—SUMMARY OF THE RELATIVE VALUES PER 100 POUNDS OF GRADED TOBACCO HARVESTED FROM THE SECOND, THIRD AND FOURTH PRIMINGS OF FIVE VARIETIES OF WRAPPER TOBACCO GROWN IN 1933 TO 1936, INCLUSIVE.

Year	301	94-2	94-4	R	Rg
1933	$72.72	$79.68	$77.59	$71.67	$78.89
1934	73.45	77.27	85.00	57.13	80.74
1935	70.63	69.84	73.70	....	77.83
1936	75.40	75.38	73.09	....	79.29
Average	73.05	75.54	77.35	64.40	79.19
Increase over 301— Cash value		2.49	4.30	–8.65	6.14
Percent		3.41	5.89	–11.84	8.41

Estimated values obtained indicate that varieties Rg, 94-4 and 94-2 proved somewhat superior and R inferior to 301. Obviously, it is not known whether this order might have been changed somewhat if data for all primings had been available.

CIGAR DATA

Representative samples of sweated leaves, about ¾ pound each, from the 1935 and 1936 crops were submitted to two cigar factories for wrapping trials on their machine-made commercial cigars. In each factory one machine with its operators was assigned to this work. The same filler and binder were furnished by the factory for use in all cigars and the data obtained therefore pertained only to the wrappers. The wrapper leaves were stemmed and handled in the usual commercial manner in the presence of a Station worker who carefully observed every operation and obtained weights at various points. All of these data, consisting of the grades and lengths of wrapper leaves, average number of cigars made per wrapper leaf, total number per pound, and number of sound cigars per pound, are given in Tables 11 and 12.

Samples of Rg leaves, measuring 14, 15, 16 and 17 inches, from the 1937 crop were tested in a corresponding manner by one of the factories. These data, given in Table 13, while not

TABLE 11.--TOTAL NUMBER OF CIGAR WRAPPERS PRODUCED, BOTH PER LEAF AND PER POUND, BY FOUR DIFFERENT VARIETIES OF WRAPPER TOBACCO.

Length of leaf (inches)	Year produced	Grade	Factory	301		94-2		94-4		Rg	
				Per leaf	Per pound	Per leaf	Per pound	Per leaf	Per pound	Per leaf	Per pound
18	1935	off color	A	4.61	736	4.52	693	4.99	678	4.57	713
19	1935	off color	B	4.83	664	4.60	625	5.23	619	4.88	679
20	1936	off color	A	5.77	632	4.65	625	4.76	553	5.69	659
21	1936	off color	B	6.54	651	5.23	635	5.21	602	6.26	666
All lengths	1935	unsorted	A	5.28	555	5.44	572	4.84	538	4.86	554
All lengths	1936	unsorted	A	5.40	576	5.16	548	4.52	526	5.51	584
All lengths	1936	unsorted	B	5.65	568	5.68	575	4.94	540	6.50	654
Average				5.44	626	5.04	610	4.93	579	5.47	644
Increase over 301—Cigars						–.40	–16	–.51	–47	.03	18
Percent						–7.35	–2.56	–9.38	–7.51	.55	2.88

TABLE 12.—TOTAL NUMBER AND THE PERCENTAGES OF SOUND WRAPPERS, AFTER THE MANUFACTURE OF CIGARS, PER POUND OF LEAF PRODUCED BY FOUR DIFFERENT VARIETIES OF WRAPPER TOBACCO.

Length of leaf (inches)	Year produced	Grade	Factory	301		94-2		94-4		Rg	
				Total	Percent	Total	Percent	Total	Percent	Total	Percent
18	1935	off color	A	697	94.77	681	98.36	652	96.25	697	97.79
19	1935	off color	B	640	96.34	603	96.52	586	94.66	655	96.42
20	1936	off color	A	609	96.35	598	95.70	533	96.39	629	95.41
21	1936	off color	B	636	97.77	617	97.27	590	98.00	651	97.76
All lengths	1935	unsorted	A	534	96.09	548	95.80	523	97.16	540	97.38
All lengths	1936	unsorted	A	564	97.88	533	97.31	511	97.28	560	95.94
All lengths	1936	unsorted	B	558	98.28	557	96.95	530	98.25	635	97.02
Average				605	96.78	591	96.84	561	96.86	624	97.16
Increase over 301—Sound cigars						–14	.06	–44	.08	19	.38
Percent						–2.31		–7.27		3.14	

strictly comparable to those given in Tables 11 and 12, are included to indicate the yields of wrappers from the shorter lengths of Rg leaves.

TABLE 13.—TOTAL NUMBERS AND PERCENTAGES OF SOUND WRAPPERS YIELDED BY THE SHORTER LENGTHS OF LEAF OF RG TOBACCO PRODUCED IN 1937.

Length (inches)	Grade	Number of wrappers		Sound wrappers per lb.	
		Per leaf	Per lb.	Total	Percent
14	unsorted	2.50	649	622	95.84
15	unsorted	3.29	780	763	97.82
16	unsorted	3.61	706	697	98.72
17	unsorted	4.14	741	730	98.52

Average yields of cigars per wrapper leaf and per pound of leaves varied considerably among the four varieties tested. Rg produced the highest average yields of cigars, followed in order by 301, 94-2 and 94-4. When the cigars were graded for soundness of wrappers, all four varieties yielded almost exactly the same percentage of sound wrappers, averaging about 97 percent. Yields of cigars per wrapper leaf were affected perhaps slightly by the differences in leaf shape, but probably much more by the toughness of the leaves which permitted them to be stretched to obtain the maximum number of wrappers.

These factory tests were considered to be of primary importance because they represent the use for which cigar-wrapper leaves are grown.

SUMMARY AND CONCLUSIONS

Tests of cigar-wrapper varieties resistant to blackshank were conducted during the years 1933 to 1936, inclusive. Observations were made on plant characteristics, grades of cured and sweated leaves, and yields and soundness of wrappers in tests on machine-made cigars.

Five resistant varieties were included in these tests, as follows: 301, 94-2, 94-4, R and Rg. The R variety was discarded after two years' tests because of poor yield and quality. Tests of the other four varieties were continued through the four-year period, and some of the more important conclusions are given.

All varieties tested showed a high degree of resistance to blackshank in comparison with check rows of a susceptible variety. All were about equally susceptible to root-knot.

Rg was latest in date of blooming but earliest in ripeness for priming. All five varieties produced leaves very similar in size and shape. Other field observations revealed differences in color and habit of growth, but these are not of primary importance.

Comparative yields were not closely determined, only the second, third and fourth primings being harvested for these tests.

Grades of cured and sweated leaves and estimated average values for three primings only indicate that Rg, 94-4 and 94-2 were somewhat superior and R inferior to 301.

Yields of wrappers per pound of leaves were largest for Rg, followed in order by 301, 94-2, and 94-4.

Rg was somewhat superior in certain important factors to the other varieties tested, followed closely by 301.

In general the data presented substantiate the opinions of the packers of cigar-wrapper tobacco and the manufacturers of cigars.

Data on the ultimate test of cigars by the smoker are not available, but manufacturers' sales indicate that cigars wrapped with leaves of blackshank-resistant varieties, particularly Rg and 301, are acceptable to the trade.

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UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
GAINESVILLE, FLORIDA
WILMON NEWELL, Director

LYSIMETER STUDIES WITH THE DECOMPOSITION OF SUMMER COVER CROPS

By

R. M. BARNETTE, H. W. JONES AND J. B. HESTER

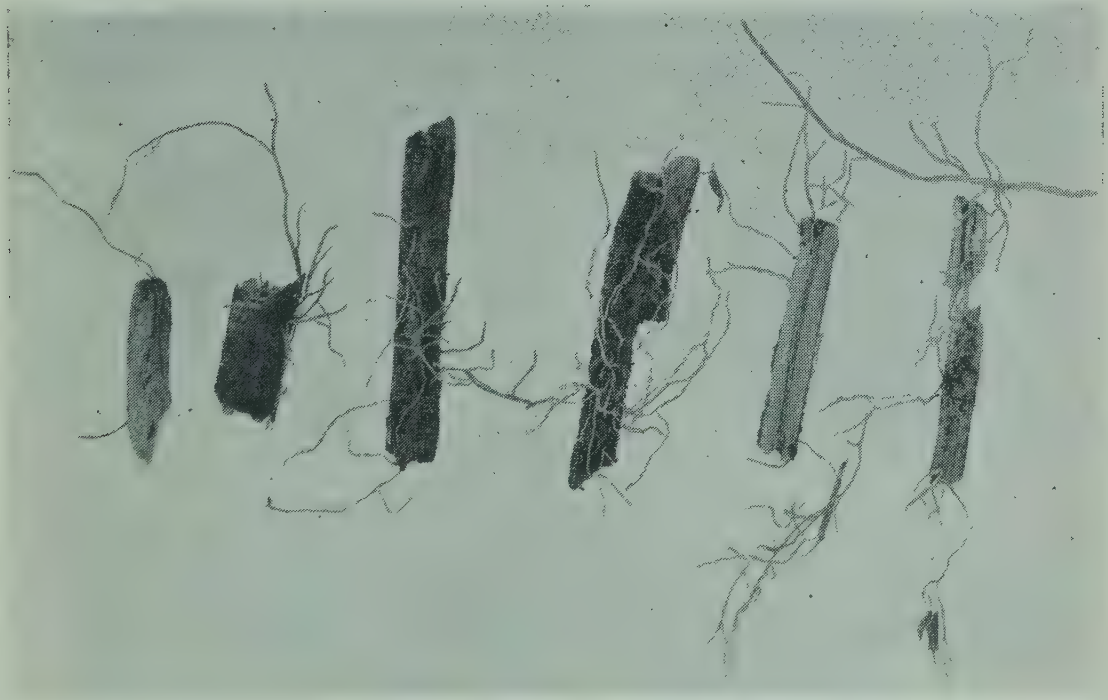

Fig. 1.—Rough lemon seedling roots growing in partially decomposed *Crotalaria striata* stems.

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LYSIMETER STUDIES WITH THE DECOMPOSITION OF SUMMER COVER CROPS

By

R. M. BARNETTE, H. W. JONES[1] AND J. B. HESTER[1]

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An adequate summer cover crop is considered essential for an economical citrus grove management program in Florida. Here, as a rule, in the summer months there is an abundant supply of rainfall. Therefore this season is an excellent time for growing a cover crop without serious competition with the tree for moisture as would be the case in the drier spring, fall and winter months. The summer cover crops are usually incorporated with the soil in the late fall months or when the harvest of the citrus fruits begins.

The many obvious effects of the growing summer cover crop are fully appreciated by the citrus grower. Thus, the lowering of the temperature of the soil during the summer months, the protective action against blowing of the soil and the prevention of leaching of plant nutrients are recognized generally as beneficial effects. However, the more intricate processes involved in

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NOTE: The authors have purposely avoided a review of the extensive literature on the effects of cover crops and green manuring crops on the soil and on plant growth. This has been done to keep the bulletin as brief and clear as possible and thus of more value to the agriculturist. Excellent and thorough reviews of this extensive literature may be found in "Principles of Soil Microbiology," S. A. Waksman: The Williams and Wilkins Co., 1937; and "Humus: Origin, Chemical Composition and Importance in Nature." S. A. Waksman: The Williams and Wilkins Co., 1938. Some of the more practical applications of cover cropping and green manuring are discussed in "Green Manuring: Principles and Practice." A. J. Pieters: John Wiley and Sons, Inc., 1927, and in numerous bulletins from the Bureau of Plant Industry and Soil Conservation Service, U.S.D.A., and the Southeastern agricultural experiment stations.

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the decomposition of the cover crops in the soil and their effect on plant growth are not understood so completely and for this reason they are especially interesting to the horticulturist.

In this work, small soil tanks or lysimeters have been used to study the decomposition of cover crops. This method permits the collection and chemical analyses of the water leaching through the soil as well as the sampling and chemical analyses of the soil, cover crops and citrus seedlings grown in the presence of decomposing cover crops.

DESCRIPTION OF LYSIMETERS

The soil tanks or lysimeters were constructed as shown in Figure 2. The arrangement of the small tanks, 17½ inches in diameter and 26 inches tall, permitted the collection of the leachings in the five gallon carboys below. Small, clean, smooth rocks prevented the soil from washing from the tanks and no difficulty was experienced in obtaining clear leachings. The tanks were placed in the open and, therefore, received the natural rainfall of this area.

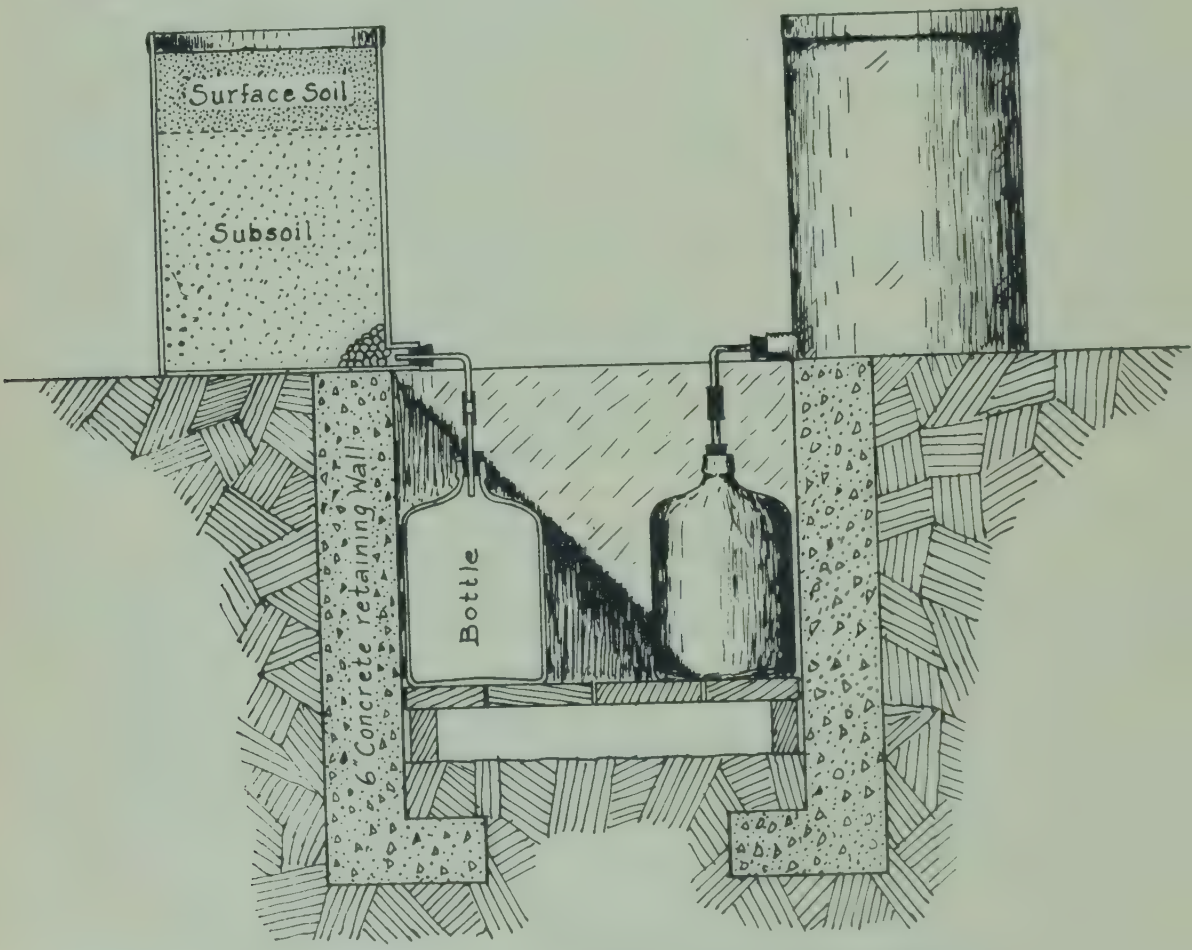

Fig. 2.—Diagram showing arrangement of small lysimeters.

The arrangement as shown in the diagram proved to be a very satisfactory temporary setup for carrying on experiments for a short period. Two series of studies have been made using this equipment. The first experiment was an orienting study of the decomposition of *Crotalaria striata* and velvet beans. This study served as a basis for planning the more comprehensive second experiment on the decomposition of *Crotalaria striata* and Natal grass. These experiments will be reported separately.

PRELIMINARY EXPERIMENTAL PROCEDURE

The purpose of the preliminary experiment was to study the effect of different methods of handling *Crotalaria striata* and velvet beans upon their decomposition in the soil, upon the leachings of rain water, upon the growth of rough lemon seedlings, and upon the soil itself. On December 8, 150 pounds of a well mixed subsoil of a Norfolk medium fine sand were placed in each of 18 lysimeters. Fifty pounds of surface soil of a Norfolk medium fine sand were placed upon this subsoil, filling the tanks to within about four inches of the top. On December 9, and on subsequent dates *Crotalaria striata* and velvet beans were added to the soil of the tanks in the same manner indicated in Table 1. Five pounds of the green material were chopped into small pieces approximately four inches in length and added to each of the treated tanks. The *Crotalaria striata* carried 35.5 percent dry matter, and analyzed 2.02 percent nitrogen on the dry basis. The velvet beans were 32.5 percent dry matter, and 2.86 percent nitrogen on the dry basis. No commercial fertilizing materials were added to the soils at any time during the experiment.

In lysimeters 3, 4, 11 and 12 the plant materials were allowed to remain undisturbed on top of the soil during the course of the experiment. In lysimeters 5, 6, 13 and 14, the fresh materials were incorporated with the surface six inches of soil. In lysimeters 7, 8, 15 and 16 the materials were allowed to lie on top of the soil from December 9 until January 23, when they were incorporated 1 to 15 inches deep with a layer of soil over them. This simulated deep plowing of dry materials. In lysimeters 9, 10, 17 and 18, the materials were allowed to lie on top of the soil from December 9 until March 2, when they were incorporated with the six inches of surface soil. This procedure simulated the incorporation of dry materials in the spring.

TABLE 1.—OUTLINE OF METHODS OF HANDLING COVER CROPS IN PRELIMINARY LYSIMETER EXPERIMENTS.

Cover Crop	Method of Handling Cover Crop	Tank No.	Tree Treatment[1]
None	No cover crop or fertilizer material	1 2	with tree without tree
Mature *Crotalaria striata*	Material used as mulch December 9	3 4	with tree without tree
	Green material incorporated with surface soil December 9	5 6	with tree without tree
	Dry material incorporated 10 to 15 in. deep January 23	7 8	with tree without tree
	Dry material incorporated with surface soil March 2	9 10	with tree without tree
Mature velvet beans	Material used as mulch December 9	11 12	with tree without tree
	Green material incorporated with surface soil December 9	13 14	with tree without tree
	Dry material incorporated 10 to 15 in. deep January 23	15 16	with tree without tree
	Dry material incorporated with surface soil March 2	17 18	with tree without tree

[1] One rough lemon seedling was planted in each alternate lysimeter on March 2.

On March 2 one rough lemon seedling was planted in each alternate lysimeter. Therefore, for each method of handling the cover crop material there was a lysimeter with a tree and one without a tree. The rough lemon seedlings were selected for uniformity and were approximately 18 inches from root tip to stem tip. There had been no leaching rains up to this time and the seedlings were watered well and the tanks leached artificially but uniformly at this time. All the rough lemon seedlings lived and made satisfactory growth. The experiment was discontinued 595 days after the addition of the cover crops to the soils and 512 days after setting the seedlings (July 26).

Whenever a leaching occurred the quantity of water leached was measured and the nitrates in the leaching were determined by the phenoldisulphonic colorimetric method.

At the close of the experiment the mulch materials were removed from the surface of the soil, washed and dried at 100 degrees Centigrade; the 0 to 9 inch and 9 to 18 inch depths of the soils were sampled and the rough lemon seedlings were washed from the soils, dried at 100 degrees Centigrade, and weighed.

EXPERIMENTAL RESULTS

EFFECT OF COVER CROPS AND METHOD OF THEIR INCORPORATION WITH THE SOIL UPON GROWTH OF ROUGH LEMON SEEDLINGS

The dry weights of the rough lemon seedlings, the percentages of nitrogen in their leaves and combined stems and roots, and the total quantities of nitrogen recovered in the seedlings are given in Table 2.

As may be seen from the data of this table, the addition of *Crotalaria striata* and velvet beans greatly increased the dry weight produced by the rough lemon seedlings. The average dry weight of all the plants grown with additions of *Crotalaria striata* was 273.6 grams, while that of the seedlings grown with velvet beans was 288.9 grams. These weights are, respectively, 2.73 and 2.88 times the weight of the plants produced in the absence of the cover crop materials.

The method of handling the cover crop apparently had some effect on the response of the rough lemon seedlings. Averaging the weights of the seedlings where the two cover crops were handled differently gives the following results: cover crops used as a mulch, 336.7 grams; green cover crops incorporated with the surface soil, 279.9 grams; dry cover crops incorporated 10 to 15 inches deep, 222.1 grams; dry cover crops incorporated with the surface soil in the spring, 286.4 grams. Thus the average results show that the mulching process has produced the largest plants; deep incorporation of the dry materials, the smallest plants; and incorporation of the green and dry materials with the surface soil, intermediate plants.

Percentages of nitrogen in the leaves and in the combined stems and roots of the rough lemon seedlings do not vary in any consistent manner with the cover crop treatments. However, the total nitrogen contained in the seedlings was lowest in the absence of cover crops. There were also appreciably lower recoveries of nitrogen in the case of the deep incorporation of *Crotalaria striata* and velvet beans than with the other methods of handling. There were no consistent variations in the recovery of nitrogen in the seedlings where other methods of handling cover crops were used.

TABLE 2.—DRY WEIGHTS AND NITROGEN CONTENT OF ROUGH LEMON SEEDLINGS GROWN WITH *Crotalaria striata* AND VELVET BEANS ADDED TO THE SOIL.

Cover Crop	Method of Handling	Dry Matter			Nitrogen		Total Nitrogen		
		Leaves	Roots and Stems	Total	Leaves	Roots and Stems	Leaves	Roots and Stems	Total
		g	g	g	%	%	g	g	g
None		24.0	76.4	100.4	1.22	0.60	0.29	0.46	0.75
Mature *Crotalaria striata*	Material used as mulch December 9	65.5	293.0	385.5	1.53	0.48	1.00	1.41	2.41
	Green material incorporated with surface soil December 9	84.9	201.8	286.7	1.53	0.72	1.29	1.45	2.74
	Dry material incorporated 10 to 15 in. deep January 23	76.4	125.0	201.4	1.32	0.58	1.01	0.73	1.74
	Dry material incorporated with surface soil March 2	76.7	170.8	247.5	1.31	0.76	1.00	1.29	2.29
Mature velvet beans	Material used as mulch December 9	90.9	224.0	314.9	1.35	0.58	1.23	1.29	2.52
	Green material incorporated with surface soil December 9	91.3	181.8	273.1	1.31	0.70	1.19	1.27	2.46
	Dry material incorporated 10 to 15 in. deep January 23	77.7	165.0	242.7	1.13	0.48	0.88	0.79	1.67
	Dry material incorporated with surface soil March 2	94.0	231.2	325.2	1.16	0.56	1.09	1.29	2.38

EFFECT OF METHOD OF INCORPORATION OF *Crotalaria striata* AND VELVET BEANS WITH THE SOIL UPON THE LEACHING OF WATER

The drainage water percolating through each lysimeter after a heavy rain was measured carefully. Total amounts of rain water that leached are given in Table 3.

TABLE 3.—Total Quantity of Water and Percentage of Total Rainfall Leaching Through Lysimeters with *Crotalaria striata* and Velver Beans Handled by Different Methods.

Cover Crop	Method of Handling	Total Leaching		Percentage of Total Rain	
		Tree	No Tree	Tree	No Tree
		L.	L.	%	%
None		152.7	174.7	39.4	45.1
Mature *Crotalaria striata*	Material used as mulch December 9	165.9	202.0	42.8	52.1
	Green material incorporated with surface soil December 9	145.5	184.1	37.5	47.5
	Dry material incorporated 10 to 15 in. deep January 23	134.7	180.5	34.8	46.6
	Dry material incorporated with surface soil March 2	139.8	174.5	36.1	45.0
Mature velvet beans	Material used as mulch December 9	145.1	214.9	37.4	55.5
	Green material incorporated with surface soil December 9	148.9	190.1	38.4	49.1
	Dry material incorporated 10 to 15 in. deep January 23	133.9	192.3	34.6	49.6
	Dry material incorporated with surface soil March 2	129.0	167.5	33.3	43.2

Total rain falling on tank was 387.5 liters or 98.27 inches.

In the series of lysimeters with trees there was no consistent variation in the leaching which could be attributed to the different methods of handling the cover crops. The percentage of the total rainfall which leached in the tree series varied from 33.3 percent to 42.8 percent in the different lysimeters.

In the series without trees, the use of *Crotalaria striata* and velvet beans as mulches increased materially the quantity of water leached over that obtained from the soil without additions of cover crop materials. The incorporation of the green materials and the deep incorporation of the dry materials increased the leaching of water somewhat but not nearly to the extent of their use as mulches. The incorporation of the dry materials with the surface soil had little or no effect on the leaching of rain water. The larger quantities of water leached from the mulched tanks with trees indicated a conservation of water in the soils due to decreased surface evaporation.

RATE OF NITRATE FORMATION FROM *Crotalaria striata* AND VELVET BEANS AS MEASURED BY LEACHING OF NITRATES FROM THE SOILS WITHOUT TREES

The lysimeters without rough lemon seedlings served as a basis for arriving at the rate of nitrate formation from *Crotalaria striata* and velvet beans as measured by the leachings of nitrates during the months subsequent to treatment of the soils with cover crops. The cumulative monthly leachings of nitrates from the lysimeters without trees are shown graphically in Figure 3. The results are expressed in grams of nitrate nitrogen leached by months from March to July 29, the quantity leached each month being added to the previous quantities leached.

There was no leaching of nitrates from December until March. Leachings of nitrates subsequent to March increased rapidly from all the lysimeters having cover crops. Leachings of nitrogen as nitrates from the soils to which cover crop materials had been added were very much larger than from the soil without cover crop materials. The incorporation of green cover crops with the surface soil and the deep incorporation of the dry material showed a larger leaching of the nitrates during the months immediately following March than did the use of the cover crops as mulch or the surface incorporation of dry materials. That the differences in the quantities of nitrates leached is not due to the quantity of water leached but to the actual quantities of nitrate formed from the cover crops may be seen in Table 3, in which the amounts of leachings are given. Thus the time for maximum rate of nitrification of the nitrogenous compounds of the cover crops is extended approximately two months by the use of the materials as a mulch or by the incorporation of the dry materials with the surface soil. Under the conditions of this experiment, this extended period of formation of nitrates evidently has reacted favorably on tree growth, as the soils which were mulched and those which had the dry material incorporated with the surface soil in the spring produced the largest seedlings.

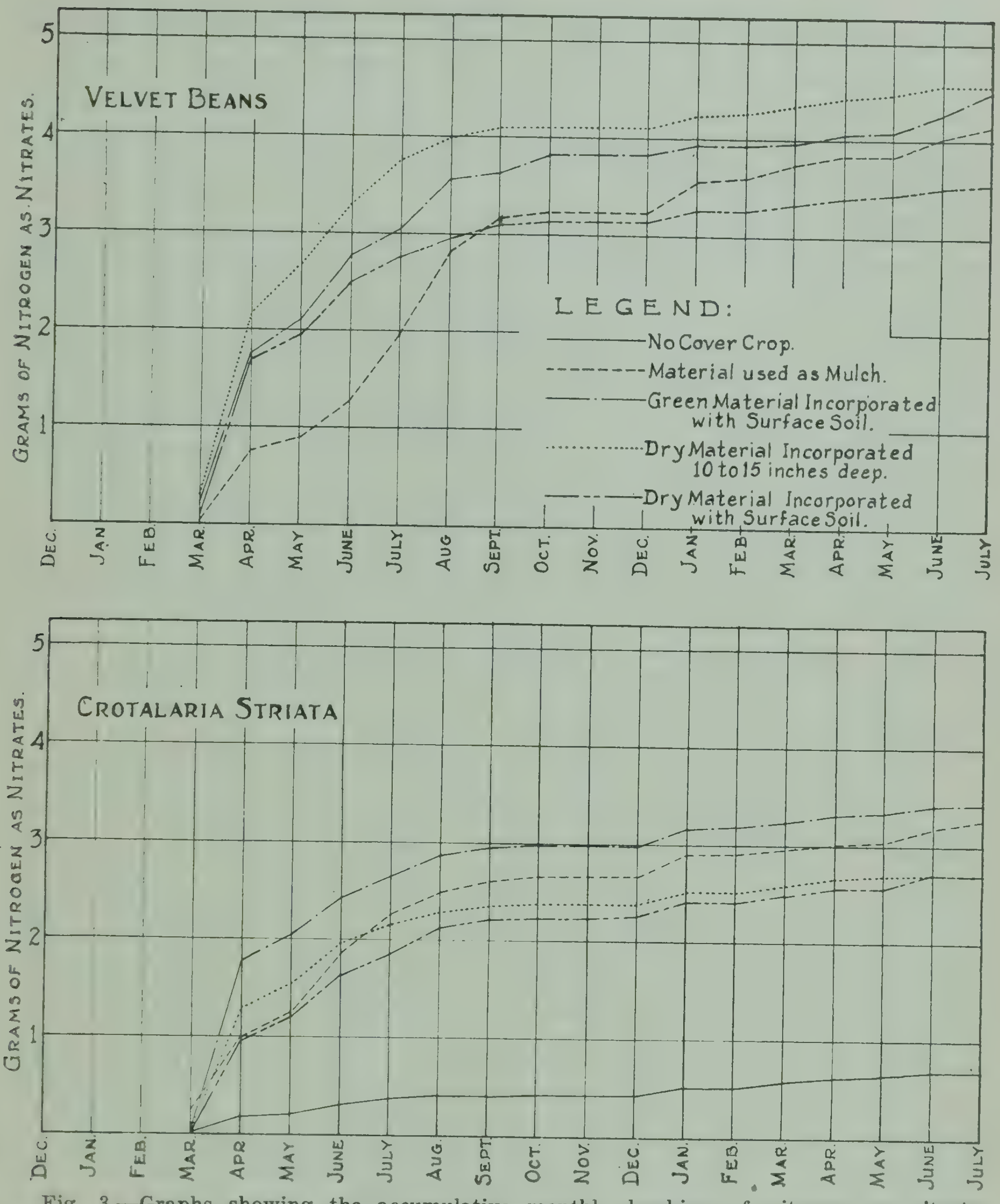

Fig. 3.—Graphs showing the accumulative monthly leaching of nitrogen as nitrates from Norfolk fine sand used in lysimeter studies with the decomposition of velvet beans and *Crotalaria striata.*

EFFECT OF COVER CROPS UPON LOSS ON IGNITION AND NITROGEN CONTENT OF THE SOIL

In this paper the term "organic matter" is understood to mean all plant and animal parts found in the soil regardless of their stage of decomposition. This organic matter includes both the plant and animal parts in the process of decomposition in the soil as well as the more decay-resistant materials which have lost their original structure and have become intimately admixed with the soil. It is easy to understand that the transition of the plant and animal parts from their original forms to well decomposed materials without recognizable structure is so gradual in a soil that any method of separation is more or less arbitrary. However, such a separation even though arbitrary is desirable in certain studies with the soil.

In this study the separation was made mechanically by screening the soil through a 2 mm. round hole sieve. The sand and the small particles of well decomposed organic matter of most Florida soils are sufficiently fine to pass very readily through this sieve. The portion remaining on the sieve is made up of coarse materials in the process of decomposition, and of debris. These include plant roots, cover crop parts and other crude organic materials in the soil. If the cover crop residues are to be studied under these conditions they must be separated from the roots of the recently grown plants, from large lumps of charcoal and from small pebbles and stones which are sometimes present in the soil. This portion of the soil organic matter may be designated as the "rough organic matter" or the "organic matter in an active stage of decomposition."

In this preliminary study the soil to which the cover crops had been added was carefully sampled at the 0 to 9 inch and the 9 to 18 inch depths. The samples were air-dried and screened through a 2 mm. round-hole sieve. The residues on the sieve were discarded and analyses were confined to the soil passing through the sieve. The soil samples were carefully pulverized in an agate mortar and pestle power mill before analysis.

The loss on ignition is considered a reliable measure of the quantity of organic matter present in sandy soils. Loss on ignition and total nitrogen content of the soil samples were determined. Averaged results of duplicate determinations on the soils of the lysimeters are given in Table 4.

The total organic matter content of both depths of soil was very slightly increased by the addition of the large quantities of *Crotalaria striata* and velvet beans. The nitrogen content of the soil was not materially affected by the addition of the cover crops. When it is considered that *Crotalaria striata* was added at the rate of approximately 23 tons of dry material per acre and the velvet beans at the rate of 21 tons per acre, it is surprising that there was so little effect upon the well decomposed organic matter content of the soil. The method of incorporation of the cover crops with the soil apparently has had no definite effect on the organic matter content of the soil.

TABLE 4.—LOSS ON IGNITION AND NITROGEN CONTENTS OF SOILS TO WHICH COVER CROPS HAD BEEN ADDED.

Cover Crop	Method of Handling	Loss on Ignition		Nitrogen	
		0-9 inches	9-18 inches	0-9 inches	9-18 inches
		%	%	%	%
None		1.871	1.384	0.038	0.026
Mature *Crotalaria striata*	Material used as mulch December 9	1.979	1.432	0.039	0.028
	Green material incorporated with surface soil December 9	1.885	1.719	0.036	0.031
	Dry material incorporated 10 to 15 in. deep January 23	1.941	1.738	0.037	0.029
	Dry material incorporated with surface soil March 2	2.062	1.724	0.042	0.022
Mature velvet beans	Material used as mulch December 9	1.960	1.679	0.043	0.022
	Green material incorporated with surface soil December 9	2.162	1.846	0.044	0.029
	Dry material incorporated 10 to 15 in. deep January 23	1.898	1.618	0.033	0.029
	Dry material incorporated with surface soil March 2	2.051	1.758	0.044	0.031

The *Crotalaria striata* and velvet beans used as a mulch were carefully collected from the surface soil, washed, dried, and analyzed for nitrogen. The results of the analyses are given in Table 5.

These results emphasize the rapidity of decay of cover crops even when used as a mulch on Florida soils. The period of decomposition of the mulches was approximately 1 year and 8 months. During this period 78.0 percent of the dry matter of *Crotalaria striata* and 74.2 percent of the dry matter of velvet beans had undergone decomposition. This decomposition had been accompanied by a transfer of 84.7 and 78.2 percent of the nitrogen of crotalaria and of the velvet beans, respectively. The nitrogen compounds had for the most part been washed into the soil underneath the mulch and either used by the rough lemon seedlings or leached from the soil. Prevailing high temperatures, favorable moisture conditions, and thorough aeration of the well drained soils in Florida are contributing factors to the rapid decomposition of organic materials added to the soils.

TABLE 5.—QUANTITIES AND NITROGEN CONTENT OF COVER CROPS REMAINING AS MULCH AFTER DECOMPOSITION PERIOD.

Material Used as Mulch	Original Material		Residue		Percentage Liberated	
	Dry Matter	N	Dry Matter	N	Dry Matter	N
	g.	%	g.	%	%	%
Crotalaria striata	805	2.02	197	1.48	75.5	82.1
			157	1.31	80.5	87.4
Average			177	1.39	78.0	84.7
Velvet beans	737	2.86	171	2.09	76.8	83.1
			209	2.69	71.7	73.3
Average			190	2.39	74.2	78.2

EXPERIMENTS WITH THE DECOMPOSITION OF *Crotalaria striata* AND NATAL GRASS

From the preliminary experiment it is evident that the incorporation of the cover crop with the surface soil or the use of the cover crop as a mulch offers some advantages. The light incorporation with the surface soil is by far the most generally used method of handling cover crops in Florida. The practice of mulching offers the disadvantage of a fire hazard and is, therefore, used to a limited extent only. However, considerable interest is manifested in this system of management of the cover crop. For this reason these two systems have been compared more extensively.

The soil tanks described previously were used to study the decomposition of *Crotalaria striata* and Natal grass. Large applications of these two cover crops were used so that sufficient materials might be available for chemical analyses. For this reason the results of the experiment may not be applied directly to grove conditions, but at the same time many apparently very fundamental relationships between cover crop decomposition, tree growth and leaching of plant nutrients were studied.

EXPERIMENTAL PROCEDURE

Each lysimeter was filled with 250 pounds of moist Norfolk fine sand on October 23. The soil in the tanks was allowed to stand undisturbed, leach, and become settled until February 27 of the following year, when 10 of the tanks were set to rough lemon seedlings of uniform size with an average green weight of

14.5 grams each. Five grams of commercial nitrate of soda were applied to each tank previous to setting the seedlings. On May 15 each tank received 5 grams of nitrate of soda, 8 grams of diammonium phosphate and 5 grams of potassium sulfate. The seedlings were allowed to grow until February 9 following, when the cover crop experiment was started. The soil of the tanks without trees was undisturbed but received the same fertilizer treatments. The leachings were collected and measured after each rain during this period, and the nitrate nitrogen content of each was determined.

On February 9 additions of the cover crop and fertilizer materials as indicated in Table 6 were made to the soil in the various tanks. The *Crotalaria striata* and Natal grass used were mature, air-dried plants. The dried materials were cut into approximately 4-inch lengths before being incorporated with the soil or used as a mulch on the surface of the soil.

TABLE 6.—COVER CROP MATERIALS AND FERTILIZERS ADDED TO THE SOILS OF THE SMALL LYSIMETERS.

Cover Crop	Amount and Handling of Cover Crop	Tank No.	Fertilizer Treatment
Dry mature *Crotalaria striata*	2 lbs. incorporated with surface soil	1 2 3 4	10 g. superphosphate 2 g. potassium sulfate
	2 lbs. used as mulch on surface	5 6 7 8	10 g. superphosphate 2 g. potassium sulfate
Dry mature Natal grass	1 lb. incorporated with surface soil	9 10 11 12	5 g. sodium nitrate 10 g. superphosphate 2 g. potassium sulfate
	1 lb. used as mulch on surface	13 14 15 16	5 g. sodium nitrate 10 g. superphosphate 2 g. potassium sulfate
No cover crop		17 18 19 20	5 g. sodium nitrate 10 g. superphosphate 2 g. potassium sulfate

Following addition of the cover crop materials to the soil, the leachings after each rain were carefully measured and the nitrate nitrogen was determined by the phenoldisulphonic acid colorimetric method and the potassium by the cobaltic nitrite method. One hundredth part of each leaching was saved for a composite sample for more detailed analyses.

Nitrate of soda at the rate of 2.5 grams per tank was added to the soil of all tanks on April 2 and June 8 of the following year. On August 31 the experiment was discontinued, after having run more than 18 months. At this time, samples of the rough lemon seedlings, the residues of the cover crops, of soils and leachings were collected for partial chemical analyses.

Tops of the rough lemon seedlings were removed at the soil level and leaves were stripped from stems and branches. The larger roots were collected and later when the soil was screened the smaller roots were separated from the residue on the screen and combined with the larger roots. The roots were washed as free as possible from adhering sand. The plant parts were dried at 100 degrees Centigrade and the dry weights obtained. The entire sample of the plant parts was ground for analyses. Standard methods for plant analyses were used.

The residues of the cover crops used as a mulch on the surface of the soil were carefully removed, dried and weighed. Residues of the cover crops which had been incorporated with the surface soil were collected by screening the entire soil mass of the 0 to 6 inch depth through a 2 mm. round-hole sieve. The residues consisted of the larger pieces of the undecomposed cover crops, the small roots of the rough lemon seedlings, the larger lumps of charcoal and the undecomposed organic materials of the original soil with small pebbles. The larger pebbles were removed and the conglomerate mixture washed three times by flotation on a 1 mm. round-hole screen placed in a large porcelain dish of such size as to permit the lighter material to float around in the screen but not to be carried off by the water. Most of the fine sand adhering to the cover crop residues was removed in this manner. The materials were removed from the screen and dried in the air. The cover crop residues were separated from the small roots, charcoal and other materials. A small paint brush was used in this separation. The separated residues of the cover crops were dried at 100 degrees Centigrade, weighed and prepared for analyses.

The air-dried soil which had been screened through the 2 mm. round-hole sieve was thoroughly mixed, quartered, and sampled. The 6 to 13 and 13 to 20 inch depths were also removed separately, screened and sampled.

A composite sample of the leachings from each of the lysimeters was obtained by taking one hundredth part by volume of the individual leachings.

Very few modifications of the standard methods for making the chemical analyses were used. The wet combustion method developed by Adams[1] was used for the carbon determinations.

EXPERIMENTAL RESULTS

EFFECT OF COVER CROPS ON GROWTH AND COMPOSITION OF ROUGH LEMON SEEDLINGS

The dry weight of the leaves, stems, branches and roots of the rough lemon seedlings grown in the lysimeters are given in Table 7. The incorporation of the *Crotalaria striata* with the surface soil produced the largest seedlings while the use of this material as a mulch produced the second largest. The use of the large application of Natal grass both incorporated with the surface soil and as a mulch produced smaller seedlings than the use of no cover crop material. The smaller growth of the seedlings in the presence of large quantities of a decomposing non-leguminous cover crop is in keeping with experimental and practical observations on the use of such materials.

The detrimental influence of the mature non-leguminous Natal grass on the plant growth may be attributed to competition of the soil microorganisms for nitrogen in the early stages of decomposition. The Natal grass used in this experiment had 0.749 percent nitrogen and 39.000 percent carbon, or a ratio of nitrogen to carbon of 1:52.87. During the early stages of decomposition of such material, nitrogen compounds are not released to the growing plants, as the microorganisms are successful competitors for the nitrogen of the soil since they require more nitrogen for their metabolic processes than is available in the materials.

The leaves of the rough lemon seedlings growing in the presence of decomposing Natal grass turned yellow at times, necessitating the application of nitrate of soda. The superior growth of the rough lemon seedlings in the presence of the decomposing *Crotalaria striata* may be attributed partially to a larger supply of nitrogen. Nitrates were formed from the crotalaria soon after its addition to the soil, as shown by the analysis of the leachings. The nitrates formed from the crotalaria became available to the rough lemon seedlings over an extended period. Comparison of analyses of leachings from lysimeters with and without seedlings showed that these nitrates were readily taken up by the young trees.

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[1] Adams, J. E., "Determination of the total carbon in soils by the wet oxidation method," Industrial and Engineering Chemistry, Analytical Edition: 6: 277-279. 1934.

TABLE 7.—DRY WEIGHTS OF ROUGH LEMON SEEDLINGS GROWN WITH *Crotalaria striata* AND NATAL GRASS INCORPORATED WITH THE SURFACE SOIL AND USED AS A MULCH.

Cover Crop	Method of Handling Cover Crop	Tank No.	Dry Weight of Plant Part: Leaves	Stem and Branches	Roots	Total
			g.	g.	g.	g.
Dry mature *Crotalaria striata*	Incorporated with surface soil	1	64	216	120	400
		2	69	227	135	431
		Average	66	222	128	416
	Mulch	5	45	154	91	290
		6	66	192	114	372
		Average	56	173	102	331
Dry mature Natal grass	Incorporated with surface soil	9	38	122	74	234
		10	32	139	70	241
		Average	35	131	72	238
	Mulch	14	27	115	64	206
No cover crop		17	41	152	86	279
		18	44	158	111	313
		Average	43	155	98	296

Percentages of nitrogen, potassium, phosphorus and calcium in the leaves, stems and roots of the rough lemon seedlings grown in the lysimeters are given in Table 8.

Average percentages of nitrogen in the dry matter of the rough lemon seedlings were 1.794, 0.895, and 0.547 for the leaves, roots, and stems, respectively. All plant parts had a higher percentage of nitrogen when grown with the cover crops. The higher percentages of nitrogen in the seedlings grown with crotalaria may be attributed to the greater supply of nitrogen added as crotalaria. The higher percentages in the seedlings of the Natal grass cultures may be attributed to the availability of nitrogen during the late stages of decomposition of the grass.

The average percentages of phosphorus in the dry matter of the rough lemon seedlings were 0.289, 0.196, and 0.111 for leaves, roots and stems, respectively. Variations in the percentages of

TABLE 8.—Percentages of Nitrogen, Phosphorus, Potassium and Calcium in the Leaves, Stems and Roots of Rough Lemon Seedlings Grown in Small Lysimeters.

Cover Crop and Method of Handling	Nitrogen			Phosphorus			Potassium			Calcium		
	Leaves	Stems	Roots	Leaves	Stems	Roots	Leaves	Stems	Roots	Leaves	Stems	Roots
	%	%	%	%	%	%	%	%	%	%	%	%
Crotalaria striata incorporated	1.847	0.580	0.973	0.275	0.113	0.129	1.425	0.491	0.282	2.964	0.761	0.782
Crotalaria striata mulch	1.777	0.575	0.889	0.286	0.123	0.169	1.512	0.574	0.278	2.701	0.651	0.733
Natal grass incorporated	1.897	0.555	0.909	0.292	0.109	0.238	2.366	0.933	0.379	1.859	0.507	0.867
Natal grass mulch	1.861	0.560	0.868	0.312	0.106	0.249	2.421	0.935	0.383	2.113	0.543	1.015
No cover crop	1.588	0.465	0.835	0.278	0.104	0.196	1.205	0.446	0.227	3.609	0.833	0.945
Average	1.794	0.547	0.895	0.289	0.111	0.196	1.786	0.676	0.309	2.649	0.659	0.868

phosphorus in the leaves and stems of the seedlings were not significant. The highest percentage of phosphorus in the roots was found in the seedlings grown with Natal grass, the lowest in the roots of plants grown with crotalaria, while the roots of the plants without cover crop additions occupied an intermediate position.

Average percentages of potassium in the dry matter of the rough lemon seedlings were 1.786, 0.676, and 0.309 for the leaves, roots and stems, respectively. Seedlings grown with Natal grass had much higher percentages of potassium in all plant parts than those grown with *Crotalaria striata* or without the addition of cover crop materials.

Likewise, the percentages of potassium in various parts of the seedlings of the crotalaria cultures were higher than those in the seedlings grown without the addition of cover crop materials.

Average percentages of calcium in the dry matter of the rough lemon seedlings were 2.649, 0.868, and 0.659 for leaves, roots and stems, respectively. The highest percentages of calcium were found in the seedlings without cover crop additions, with the exception of the roots of plants grown with the Natal grass mulch. Percentages of calcium in leaves and stems of plants grown with *Crotalaria striata* were substantially higher than those grown with Natal grass.

PERCENTAGE OF ORGANIC MATTER, NITROGEN AND CARBON IN COVER CROPS BEFORE AND AFTER DECOMPOSITION

Organic matter, nitrogen and carbon contents of samples of the original cover crop materials, and of residues at the end of the experiment, were determined. Percentages of these plant constituents liberated from the original cover crops were calculated from the weights and analyses of the materials. Results of the analyses and calculations are given in Table 9. The chemical analyses were calculated on a silicon dioxide and sand free basis because of the very great variability of the sand content in the materials used as a mulch or incorporated with the soil. The period of decomposition which the cover crops underwent was from February 9 one year to August 31 of the next, or 569 days.

The change in composition of the cover crops after their addition to the soil is interesting. The percentage of organic matter in the residues of the cover crops, whether incorporated with the soil or used as a mulch, was slightly lower than that of the original materials, but hardly significant. Residues of both *Crotalaria striata* and Natal grass increased in percentage of nitrogen over the original materials. At the end of the period of decomposition these residues had a practically constant percentage of nitrogen of approximately 1.8 percent, regardless of the original material and the method of handling. The percentage of carbon in the original crotalaria sample was 41.210 and in the Natal grass 39.000. These percentages remained virtually unchanged in the residues of these materials after decomposition in the soil or use as a mulch.

The carbon-nitrogen ratio of the original *Crotalaria striata* was 31.030 and that of Natal grass was 52.870. After decomposing in the soil or as a mulch, residues of these two cover crops had a practically constant carbon-nitrogen ratio varying only from 22.010 to 23.610. Thus, through decomposition processes taking place in the soil these two materials with a widely divergent carbon-nitrogen ratio, were brought to practically the same percentage composition with regard to nitrogen and carbon.

However, during this period of decomposition a very large part of the organic material added to the soil in the form of cover crops had been oxidized. For *Crotalaria striata* incorporated with the surface soil, 87.550 percent of the organic matter, 82.537 percent of the nitrogen and 87.450 percent of the carbon applied in the material had been oxidized. The values of the *Crotalaria striata* used as a mulch were lower, being 72.200 percent for the organic matter, 63.064 for the nitrogen and 72.350 percent for the carbon. The corresponding values for the Natal grass incorporated with the soil were 95.930 percent for the organic matter, 91.626 for the nitrogen, and 96.260 percent for the carbon; and for the Natal grass used as a mulch, 74.880 percent for the organic matter, 36.597 for the nitrogen, and 73.936 for the carbon. Thus, the use of *Crotalaria striata* and Natal grass as a mulch has definitely decreased the rates of decomposition of the organic constituents of these materials. However, the analyses show that the residues had about the same percentages of organic matter, nitrogen and carbon regardless of the method of handling.

PERCENTAGE OF CALCIUM, PHOSPHORUS AND POTASSIUM IN COVER CROPS BEFORE AND AFTER DECOMPOSITION

Calcium, phosphorus and potassium in the cover crops and in their residues were determined by standard methods for plant analysis. From these analyses and from weights of cover crops added to the soil, and of residues in the soil at the end of the period of decomposition, percentages of these elements which

TABLE 9.—PERCENTAGES OF ORGANIC MATTER, NITROGEN AND CARBON IN ORIGINAL COVER CROP MATERIALS AND IN THEIR RESIDUES AFTER PARTIAL DECOMPOSITION.

Constituent	Percentage Composition[1]						Percentage Liberated[2]			
	Crotalaria striata			Natal Grass			*Crotalaria striata*		Natal Grass	
	Original Material	Residue		Original Material	Residue					
		Incorporated	Mulch		Incorporated	Mulch	Incorporated	Mulch	Incorporated	Mulch
	%	%	%	%	%	%	%	%	%	%
Organic matter	96.694	94.264	95.189	96.068		91.890	87.550	72.200	95.930	74.880
Nitrogen	1.328	1.864	1.765	0.749	1.540	1.891	82.537	63.064	91.626	36.597
Carbon	41.210	41.560	41.000	39.000	36.360	41.620	87.452	72.350	96.260	73.936
C/N ratio	31.030	22.300	23.230	52.870	23.610	22.010				

[1] Average of quadruplicate samples calculated on SiO_2 and sand free basis except for incorporated Natal grass.

[2] Determined from weight of materials and percentage composition, on a dry basis.

had been removed from the cover crops during the period of decomposition were calculated. Results of chemical analyses and of calculations are given in Table 10. The results were calculated on a silicon dioxide and sand free basis because of the great variation in the sand content of the residues.

Percentages of calcium in the residues of both *Crotalaria striata* and Natal grass were very substantially higher than those in the undecomposed plants. Percentages of phosphorus in the residues of crotalaria were lower than in the original material while the residue of the Natal grass mulch had a higher percentage of phosphorus than the original material. Percentages of potassium in the residues were much lower than percentages found in the original plant materials.

Of the calcium contained in the original sample of *Crotalaria striata,* 75.421 percent was liberated by incorporation with soil and 51.248 percent by mulching; of the phosphorus, 93.539 percent by incorporation with the soil and 88.625 percent by mulching; of the potassium 96.188 percent by incorporation with the soil, and 90.840 percent by mulching. Thus, the use of *Crotalaria striata* as a mulch has materially decreased the rate of liberation of calcium, phosphorus and potassium in comparison with the incorporation of the material with the soil. There was not enough residue of the Natal grass incorporated with the soil to make the partial analysis; however, the Natal grass used as a mulch showed a slight gain in calcium, a liberation of 47.502 percent of the phosphorus, and 96.107 percent of the potassium contained in the undecomposed material.

It is evident that the oxidation of such large quantities of organic matter and the liberation of the mineral constituents from the organic matter must exert a definite influence not only upon tree growth but also upon the leaching of plant nutrients from the soil.

TOTAL QUANTITIES OF WATER AND CONCENTRATION OF NITROGEN, POTASSIUM AND CALCIUM IN WATER LEACHED FROM SOILS

Total quantities of water leaching through the lysimeters were determined by adding together the volumes of the individual leachings. Total nitrogen leached as nitrates was determined by adding the grams of nitrogen removed by the individual percolates; amounts of potassium and calcium by analysis of composite samples of the leachings.

TABLE 10.—PERCENTAGES OF CALCIUM, PHOSPHORUS AND POTASSIUM IN COVER CROPS BEFORE AND AFTER DECOMPOSITION AND PERCENTAGE LIBERATED BY DECOMPOSITION.

Constituent	Percentage Composition[1]						Percentage Liberated[2]			
	Crotalaria striata			Natal Grass			*Crotalaria striata*		Natal Grass	
	Original Material	Residue		Original Material	Residue					
		Incor-porated	Mulch		Incor-porated	Mulch	Incor-porated	Mulch	Incor-porated	Mulch
	%	%	%	%	%	%	%	%	%	%
Calcium	0.759	1.499	1.331	0.339	——	1.657	75.421	51.248	——	Gain
Phosphorus	0.489	0.254	0.200	0.212	——	0.444	93.539	88.625	——	47.502
Potassium	0.297	0.093	0.098	0.728	——	0.112	96.188	90.840	——	96.107

[1] Average of quadruplicate samples calculated on SiO_2 and sand free basis.

[2] Determined from weight of materials and percentage composition.

Total volume of water leached and concentrations of nitrogen, potassium and calcium in the leachings, expressed as parts per million, are tabulated in Table 11.

In these experiments the air-dried *Crotalaria striata* was applied at the rate of approximately 26 tons per acre, and Natal grass at 13 tons per acre. As may be seen from the volumes of water leached from the tanks, these amounts of rough organic matter have influenced definitely the water relationships in the soil. The leachings from the tanks without trees show that in every instance the incorporation or use as a mulch of such large quantities of organic matter increased very materially the volume of water leached. The smaller application of Natal grass increased the volume of leaching more than *Crotalaria striata*. This may be attributed to the physical properties of the Natal grass; for example, its fine, easily matted leaves and stems form a more effective mulch in comparison with the easily decomposed leaves and large woody stems of the crotalaria.

The use of *Crotalaria striata* as a mulch did not increase the volume of water leached more than its incorporation with the surface soil. Leaves and small stems of crotalaria decomposed rapidly and soon left only the larger, more decay-resistant, woody stems on the soil surface. These were not effective in reducing evaporation from the surface of the soil. On the other hand, the interlacing of the fine stems and leaves of the Natal grass formed an excellent mulch on the surface of the soil and materially reduced evaporation.

That this change in the water relationships in the soil may have been a contributing factor in the influence exerted by the cover crop materials on plant growth is indicated by the data obtained from the cultures growing seedlings. *Crotalaria striata*, incorporated with the surface soil or used as a mulch, produced the largest seedlings of the experiment. The vigorous seedlings in these cultures had a greater supply of available moisture than those growing without the addition of cover crops as shown by the leachings from the lysimeters without seedlings. That the seedlings in the crotalaria treated soil used this moisture is shown by the volumes of leachings which were not significantly greater from these tanks than from the tanks without cover crops. On the other hand, the poor growth conditions in the soils treated with Natal grass resulted in small plants and a poor utilization of the conserved water, with a greater leaching of water in these tanks as compared to that obtained from the cultures without cover crops.

TABLE 11.—TOTAL QUANTITIES OF WATER LEACHED AND THE CONCENTRATIONS OF NITROGEN AS NITRATES, POTASSIUM AND CALCIUM IN LEACHINGS OF SOILS WITH *Crotalaria striata* AND NATAL GRASS INCORPORATED WITH THE SURFACE SOIL AND USED AS A MULCH.

Cover Crop	Method of Handling	Liters of Water Leached		p.p.m. of N as Nitrate in Leaching		p.p.m. of K in Leaching		p.pm. of Ca in Leaching	
		Without Seedling	With Seedling	Without Seedling	With Seedling	Without Seedling	With Seedling	Without Seedling	With Seedling
Dry mature *Crotalaria striata*	Incorporated with surface soil	121.6	62.8	38.5	5.2	11.4	1.3	53.4	31.2
	Used as mulch	120.9	67.6	30.8	1.9	13.9	1.2	43.2	23.9
Dry mature Natal grass	Incorporated with surface soil	138.8	76.4	19.6	6.1	14.8	1.7	29.8	23.8
	Used as mulch	145.3	108.8	16.8	6.4	11.6	1.0	27.0	21.8
No cover crop		86.7	64.4	27.6	7.5	6.4	0.6	40.4	25.0

If the rough lemon seedlings had been without effect upon the concentration of plant nutrients in the leachings, the smaller leachings from the cultures with seedlings would have contained higher concentrations of these nutrient elements for any given cover crop treatment. However, the results obtained show that this has not been the case. In every instance the concentrations of nitrate nitrogen, potassium and calcium were very much larger in the leachings from the cultures without seedlings. This indicates a very definite absorption and utilization of these nutrient elements by the seedlings.

Concentration of the nitrate nitrogen in leachings from the lysimeters without trees was highest from the soils in which *Crotalaria striata* had been incorporated and next highest where it had been used as a mulch. The concentration of nitrate nitrogen from the soil without any cover crop additions was substantially higher than that from the soil to which Natal grass had been added. This lower concentration of nitrate nitrogen from the Natal grass cultures resulted partially from the larger volumes of water leached through these tanks and partially from a transitional fixation of nitrogen during the early decomposition of the non-leguminous grass with a low nitrogen content.

The concentration of nitrate nitrogen in leachings from tanks with seedlings was highest from soils without cover crop additions and lowest in leachings from tanks where *Crotalaria striata* was used and where the trees were making the most vigorous growth. Very low concentrations of nitrate nitrogen in leachings from soils with rough lemon seedlings in comparison with those from soils without seedlings indicate a relatively efficient utilization of the nitrates by the seedlings.

The concentration of potassium in leachings from soils to which mature *Crotalaria striata* and Natal grass had been added and without rough lemon seedlings was approximately twice that from soil without cover crops. There were no significant differences in concentration of potassium in leachings from soil in which *Crotalaria striata* and Natal grass had been incorporated or used as a mulch.

The concentration of potassium in leachings from soils to which cover crops had been added and in which rough lemon seedlings had grown was higher than that to which no cover crops had been added. The very low concentration of potassium in the leachings from the soils with rough lemon seedlings in comparison with those from the soils without rough lemon seedlings indicates a very efficient utilization by the seedlings of the potassium added as potassium sulfate and liberated from the cover crops by decomposition processes.

The concentration of calcium in leachings from soils without rough lemon seedlings was 53.4 p.p.m. where *Crotalaria striata* had been incorporated with the soil; 43.2 p.p.m. where it was used as a mulch; and 40.4 p.p.m. where no cover crops were used. Where Natal grass was incorporated with the surface soil the concentration was 29.8 p.p.m. in the leachings, and where it was used as a mulch 27.0 p.p.m. The lower concentration of calcium in the leachings from the soil to which Natal grass had been added may be attributed partly to the greater volume of water leached from these lysimeters.

The concentrations of calcium in leachings from soils with seedlings were all lower than from those without seedlings but show no definite correlation with the various cover crop treatments. However, these lower concentrations of calcium in the leachings from the soils with trees do indicate an absorption of the calcium by the seedlings. The smaller, slower growing seedlings of the Natal grass lysimeters evidently absorbed much less calcium than the more vigorous plants in the other cultures.

Average parts per million of potassium in the leachings for each month during which water percolated through the lysimeters are given in Table 12. Results from lysimeters without trees indicate that a higher concentration of potassium was soluble in soils to which *Crotalaria striata* and Natal grass had been added than in soil without additions of cover crops. The comparatively low concentrations of potassium in leachings from tanks with seedlings indicate an effective utilization of potassium by rough lemon seedlings during all months when leachings were collected, including periods of both high and low temperatures.

DISTRIBUTION OF NITROGEN, PHOSPHORUS, POTASSIUM AND CALCIUM IN LEACHINGS, IN ROUGH LEMON SEEDLINGS AND IN COVER CROP RESIDUES

From results of analyses given in the preceding tables it is evident that the nitrogen, phosphorus and potassium, and in most instances the calcium of the cover crop materials, were made soluble and mobile through the decomposition of organic materials in the soils and by rain. Also the growth and percentage composition of rough lemon seedlings indicate a direct influence of these cover crops on the seedlings. Thus the distribution of nitrogen, phosphorus, potassium and calcium in the leachings, rough lemon seedlings and cover crop residues is of interest.

TABLE 12.—AVERAGE MONTHLY CONCENTRATION OF POTASSIUM IN THE LEACHINGS FROM THE SOIL WITH AND WITHOUT COVER CROP ADDITIONS.

Cover Crop	Method of Handling		1931 - 1932							
			Feb.	March	April	July	Aug.	March	June	Aug.
			ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.
Mature *Crotalaria striata*	Incorporated with surface soil	Tree	0.73	1.26	1.80	1.63	1.40	0.55	0.43	——
		No Tree	4.52	8.35	12.80	8.03	4.89	8.60	8.90	5.20
	Mulch	Tree	1.43	2.25	4.26	0.80	2.10	0.67	0.54	——
		No Tree	3.20	5.66	12.80	5.66	7.21	12.30	14.10	8.65
Mature Natal grass	Incorporated with surface soil	Tree	0.86	2.76	2.80	1.34	2.91	1.03	1.21	——
		No Tree	4.60	6.90	10.00	5.42	10.00	12.00	20.60	9.60
	Mulch	Tree	1.00	1.80	1.60	0.65	1.60	0.92	0.92	——
		No Tree	2.79	6.90	7.80	3.93	7.78	9.35	16.00	8.30
No cover crop		Tree	1.35	1.73	1.84	1.27	0.79	0.42	0.84	——
		No Tree	3.40	5.98	6.13	0.98	4.27	5.95	4.50	4.00

Nitrogen.—The quantities of nitrogen added in the form of fertilizer salts and cover crop materials and the quantities found in the leachings, rough lemon seedlings and cover crop residues are given in Table 13.

All rough lemon seedlings were given the same fertilizer treatment from the time they were transplanted on February 27 until February 9 of the following year, when the cover crop materials were added to the soils. During this period of establishment of the seedlings, 3.225 grams of nitrogen in the form of diammonium phosphate and nitrate of soda were added to each culture.

The nitrogen leached during this period was determined separately and the quantities are given in the columns of Table 13, headed, "In first leaching." The quantities of nitrogen leached from the lysimeters with seedlings amounted to approximately 50 percent of the quantity applied. An average of 81 percent was leached from the lysimeters without seedlings.

Nitrogen added as *Crotalaria striata* amounted to 11.421 grams, while only 3.310 grams were added as Natal grass. With applications of nitrate of soda, total quantities of nitrogen applied to *Crotalaria striata* cultures was 15.411 grams, to Natal grass cultures 8.065 grams and to cultures without cover crops 4.755 grams.

Leachings of nitrogen compounds from the soil after the addition of cover crop materials was very small for the lysimeters with seedlings. This indicates a very effective utilization of both nitrogen and water by the rough lemon seedlings during this period. Relatively large quantities of nitrogen were leached as nitrates from the lysimeters without seedlings.

Larger quantities of nitrate nitrogen were leached from the soils in which *Crotalaria striata* had been incorporated than from those where this leguminous cover crop had been used as a mulch. On the other hand, residues of crotalaria used as a mulch contained over twice as much nitrogen as those of the same material incorporated with the surface soil. The same general relationships were found to hold for the non-leguminous Natal grass, though the quantities of nitrogen added and found in the leachings and cover crop residues were correspondingly smaller. These larger quantities of nitrogen, found in residues of cover crops used as mulches, indicate a definitely slower decomposition of cover crop materials when they were used as mulches.

It is interesting to note that in cultures without cover crop materials there was practically total recovery of the nitrogen

TABLE 13.—DISTRIBUTION OF NITROGEN ADDED TO NORFOLK FINE SAND AS FERTILIZERS AND COVER CROP MATERIALS IN LEACHINGS, ROUGH LEMON SEEDLINGS AND COVER CROP RESIDUES.

Cover Crop	Method of Handling	Added Before Cover Crop	Added as Cover Crop	Added with or After Cover Crop	Total	Seedling					No Seedling			
						In First Leaching[1]	In Second Leaching[2]	In Cover Crop Residue	In Seedling	Total	In First Leaching[1]	In Second Leaching[2]	In Cover Crop Residue	Total
		g.	g.	g.	g.	g.	g.	g.	g.	g.	g.	g.	g.	g.
Mature *Crotalaria striata*	Incorporated with surface soil	3.225	11.421	0.765	15.411	1.899	0.330	1.994	3.752	7.975	2.874	4.680	1.994	9.548
	Used as mulch	3.225	11.421	0.765	15.411	2.117	0.130	4.218	2.897	9.362	2.748	3.720	4.218	10.686
Mature Natal grass	Incorporated with surface soil	3.225	3.310	1.530	8.065	1.624	0.470	0.277	2.045	4.416	2.609	2.720	0.277	5.606
	Used as mulch	3.225	3.310	1.530	8.065	1.707	0.700	2.099	1.701	6.207	2.444	2.440	2.099	6.983
No cover crop		3.225	——	1.530	4.755	1.584	0.480	——	2.222	4.286	2.488	2.390	——	4.874

[1] Before addition of cover crop materials.

[2] After addition of cover crop materials.

added as fertilizer salts. The nitrogen was recovered in the leachings and seedlings in the case of the cultures with rough lemon seedlings and in the combined leachings in the cultures without seedlings.

The quantity of nitrogen recovered in the rough lemon seedlings was relatively low in comparison with quantities added in the form of cover crop and nitrogenous fertilizing materials. Percentages of nitrogen recovered in the rough lemon seedlings were 24 percent for those grown with *Crotalaria striata* incorporated with the surface soil, 18 percent for seedlings grown with *Crotalaria striata* used as a mulch, 25 percent for those grown with Natal grass incorporated with the surface soil, 21 percent for those grown with Natal grass used as a mulch and 46 percent for seedlings grown without cover crop additions. The quantity of nitrogen recovered was definitely correlated with the size of the seedlings, the higher quantity being recovered in the larger seedlings grown in the cultures which had additions of *Crotalaria striata* and the lower quantities in the smaller plants of the Natal grass cultures.

The low recovery of nitrogen in seedlings of the Natal grass cultures may be attributed to competition between microorganisms and the plant for the nitrogen compounds during early stages of decomposition of the non-leguminous cover crop. This effect of non-leguminous cover crops on plant growth is sometimes encountered under grove conditions when excessively large quantities of mature grass or similar materials are incorporated with the soil and adequate provision for sufficient nitrogen both to decompose the organic matter and to supply the growing plant is not made.

Quantities of nitrogen not accounted for by leachings, cover crop residues and rough lemon seedlings were found in the soil for the most part. However, it is difficult to make sufficiently accurate analyses of such a heterogeneous material as the soil that will detect a few grams of nitrogen in several hundred thousand grams.

Phosphorus.—The quantities of phosphorus added to the cultures as ammonium phosphate, superphosphate and cover crop materials, and those found in the cover crop residues and rough lemon seedlings are given in Table 14. The leachings were tested at intervals for phosphorus but only traces were found. Residues of the incorporated cover crop materials and of the mulches contained small quantities of phosphorus.

TABLE 14.—DISTRIBUTION OF PHOSPHORUS ADDED TO NORFOLK FINE SAND IN THE FORM OF FERTILIZERS AND COVER CROP MATERIALS, IN COVER CROP RESIDUES AND ROUGH LEMON SEEDLINGS.

Cover Crop	Method of Handling	Added Before Cover Crop	Added as Cover Crop	Added with Cover Crop	Total	In Cover Crop Residue	In Seedling
		g.	g.	g.	g.	g.	g.
Dry mature *Crotalaria striata*	Incorporated with surface soil	1.778	4.205	0.780	6.763	0.272	0.597
	Used as mulch	1.778	4.205	0.780	6.763	0.478	0.545
Dry mature Natal grass	Incorporated with surface soil	1.778	0.937	0.780	3.495	——	0.416
	Used as mulch	1.778	0.937	0.780	3.495	0.492	0.365
No cover crop		1.778	——	0.780	2.558	——	0.472

Highest quantities of phosphorus were recovered in the larger seedlings grown with *Crotalaria striata,* lowest in the smaller seedlings of the Natal grass cultures. The percentages of phosphorus recovered were small in all cultures. The phosphorus applied both as fertilizing and cover crop materials evidently was readily retained by the soil, as only very small quantities were found in the cover crop residues, seedlings and leachings.

Potassium.—The quantities of potassium added to the cultures as potassium sulfate and cover crop materials, and those found in the leachings collected after the addition of cover crop materials, in the residues and in the rough lemon seedlings, are given in Table 15.

Due to the much higher percentage of potassium in Natal grass than in *Crotalaria striata,* a larger quantity was added to the grass cultures despite the much smaller quantities of the cover crop. As noted before, this additional quantity of potassium was reflected in a higher percentage of potassium in the rough lemon seedlings grown with Natal grass than those grown in other cultures. This higher percentage resulted in practically as large a recovery of potassium in these smaller seedlings as in the larger seedlings of the *Crotalaria striata* cultures. There was a much greater recovery of potassium in seedlings grown with cover crops than in the cultures without cover crop additions.

Leachings from cultures with rough lemon seedlings contained very small quantities of potassium, as did the crop residues. Leachings from cultures without seedlings contained relatively large quantities of potassium, especially those from the soils with addition of cover crop materials. The potassium of the cover crop materials and of the potassium sulfate evidently had been readily available to the seedlings and utilized by them.

Calcium.—The quantities of calcium added to the lysimeters as cover crop materials and superphosphate, and the quantities found in the leachings, rough lemon seedlings and cover crop residues are given in Table 16.

Cultures in which *Crotalaria striata* was used received more than four times as much calcium in the form of cover crops as did the Natal grass cultures. The quantity of calcium added as superphosphate was the same for all cultures. It is impossible from the analysis to determine how much calcium was taken up by the rough lemon seedlings in the period of establishment, or before the cover crop materials were added. The leachings dur-

TABLE 15.—DISTRIBUTION OF POTASSIUM ADDED TO NORFOLK FINE SAND IN THE FORM OF FERTILIZERS AND COVER CROP MATERIALS IN LEACHINGS, COVER CROP RESIDUES AND ROUGH LEMON SEEDLINGS.

Cover Crop	Method of Handling	Added Before Cover Crop	Added as Cover Crop	Added with Cover Crop	Total	Seedling				No Seedling		
						In First Leaching[1]	In Second Leaching	In Cover Crop Residue	In Seedling	In First Leaching[1]	In Second Leaching	In Cover Crop Residue
		g.	g.	g.	g.		g.	g.	g.		g.	g.
Dry mature *Crotalaria striata*	Incorporated with surface soil	1.990	2.554	0.796	5.340	——	0.080	0.099	2.391	——	1.390	0.099
	Used as mulch	1.990	2.554	0.796	5.340	——	0.080	0.234	2.123	——	1.680	0.234
Dry mature Natal grass	Incorporated with surface soil	1.990	3.218	0.796	6.004	——	0.130	——	2.323	——	2.050	——
	Used as mulch	1.990	3.218	0.796	6.004	——	0.110	0.125	1.974	——	1.680	0.125
No cover crop		1.990	——	0.796	2.786	——	0.040	——	1.431	——	0.560	——

[1] No analyses made.

ing this preliminary period were not analyzed for calcium but treatments were uniform within the series for cultures with and without seedlings.

The larger rough lemon seedlings grown in cultures with *Crotalaria striata* incorporated with the surface soil contained by far the larger quantities of calcium. Seedlings grown without the addition of cover crop materials and those grown with *Crotalaria striata* used as a mulch contained the second highest amounts of calcium. The smaller seedlings grown with Natal grass contained approximately half as much calcium as the other seedlings. The percentage of calcium in leaves and stems of the seedlings grown in the Natal grass cultures was definitely lower than that in the leaves and stems of the other plants. Considering the leaching of calcium from both the lysimeters with seedlings and those without seedlings, there is some evidence that the decomposition of Natal grass has influenced the absorption of calcium by the seedlings.

Very materially larger quantities of calcium were leached from the cultures without seedlings than from those with seedlings. Residues of the cover crop materials used as mulches contained significantly higher quantities of calcium than the smaller residues of materials incorporated with the surface soil. Residues of the Natal grass mulch contained a larger quantity of calcium than the original material. Without doubt this is due to the admixture of soil and fertilizer with the Natal grass residues.

Considering the total quantities of calcium in the leachings, cover crop residues and seedlings, cultures with *Crotalaria striata* showed a slight gain of calcium cover crop residues. There was a practical balance of calcium in the cultures with Natal grass incorporated with the surface soil with seedlings, but a slight loss of calcium without seedlings. Cultures with Natal grass used as a mulch and those without cover crops indicate a definite drain on the calcium of the soil.

Analyses of Soils.—The average percentages of nitrogen in the 0 to 6, 6 to 13, and 13 to 20 inch and of the loss on ignition (organic matter) in the 0 to 6 and 13 to 20 inch depths of the soils of the lysimeters after screening through a 2 mm. round-hole sieve are given in Table 17. The incorporation of *Crotalaria striata* with the surface soil (0 to 6 inches) has increased significantly the nitrogen and organic matter content of the soil. The other differences in percentages of nitrogen and organic

TABLE 16.—DISTRIBUTION OF CALCIUM ADDED TO NORFOLK FINE SAND IN THE FORM OF FERTILIZERS AND COVER CROP MATERIALS IN LEACHINGS, ROUGH LEMON SEEDLINGS AND COVER CROP RESIDUES.

Cover Crop	Method of Handling	Added Before Cover Crop	Added as Cover Crop	Added with Cover Crop	Total	Seedling					No Seedling			
						In First Leaching[1]	In Second Leaching[2]	In Cover Crop Residue	In Seedling	Total	In First Leaching[1]	In Second Leaching[2]	In Cover Crop Residue	Total
			g.	g.	g.		g.	g.	g.	g.		g.	g.	g.
Dry mature *Crotalaria striata*	Incorporated with surface soil	None	6.527	2.032	8.559	—	1.960	1.604	4.646	8.210	—	6.490	1.604	8.094
	Used as mulch	None	6.527	2.032	8.559	—	1.620	3.181	3.386	8.187	—	5.230	3.181	8.411
Dry mature Natal grass	Incorporated with surface soil	None	1.498	2.032	3.530	—	1.820	—	1.939	3.759	—	4.140	—	4.140
	Used as mulch	None	1.498	2.032	3.530	—	2.370	1.839	1.843	6.052	—	3.930	1.839	5.769
No cover crop		None	—	2.032	2.032	—	1.610	—	3.769	5.379	—	3.500	—	3.500

[1] No analyses made.

matter are well within the limits of error of this type of experimentation.

TABLE 17.—PERCENTAGES OF NITROGEN AND ORGANIC MATTER IN SOIL TO WHICH *Crotalaria striata* AND NATAL GRASS HAD BEEN ADDED.

Cover Crop and Method of Handling	Nitrogen 0-6 Inches	Nitrogen 6-13 Inches	Nitrogen 13-20 Inches	Loss on Ignition 0-6 Inches	Loss on Ignition 13-20 Inches
	%	%	%	%	%
Dry *Crotalaria striata* incorporated with surface soil	0.057	0.043	0.045	2.211	1.951
Dry *Crotalaria striata* used as mulch	0.048	0.042	0.042	2.062	1.813
Dry Natal grass incorporated with surface soil	0.046	0.042	0.043	2.013	1.849
Dry Natal grass used as mulch	0.042	0.043	0.041	1.941	1.784
No cover crop	0.043	0.044	0.040	1.985	1.801

SUMMARY

In the preliminary experiment, *Crotalaria striata* and velvet beans were added to the soil in lysimeters at the rate of 5 pounds of green material per culture. These cover crop materials were added to the soil on December 8 and rough lemon seedlings were set in the soil on March 2 of the following year. Thus a period of decomposition of approximately three months elapsed between the addition of cover crop materials to the soil and the setting of seedlings. In addition, the seedlings required several weeks to become established and to utilize the plant nutrients of the soil and decomposing cover crop materials. No leaching of rain water occurred between December 8 and March 2, but the soils were artificially leached when the seedlings were set.

Four methods were used for adding each cover crop to the soil. They were: (1) green cover crop materials cut into approximately 4-inch lengths used as a mulch; (2) chopped green materials incorporated with the surface six inches of soil; (3) chopped green materials allowed to remain on the surface of the soil from December 9 until January 23 and then incorporated 10 to 15 inches deep in the soil; (4) chopped green materials remained on the surface from December 9 to March 2, when they were incorporated with the surface six inches of soil. These treatments with a culture using the soil without cover crop additions made up the experiment. A series of these lysimeters was set with rough lemon seedlings on March 2. Another series without seedlings was maintained for each of the different methods of handling the two cover crops. The experiment was discontinued on July 26 of the year after the seedlings were set. The results are summarized as follows:

1. Average dry weight of rough lemon seedlings grown with *Crotalaria striata* was 2.73 and with velvet beans 2.88 times the average weight of seedlings grown without the addition of cover crop materials.

2. The use of *Crotalaria striata* and velvet beans as a mulch produced the largest rough lemon seedlings. The incorporation of these materials 10 to 15 inches deep in the soil yielded the smallest seedlings, while the incorporation of green and dry materials with the surface soil produced plants intermediate in size.

3. Percentages of nitrogen in the rough lemon seedlings did not vary in any consistent manner with the method of handling the cover crops. The total nitrogen recovered in the seedlings was greatest in those grown with *Crotalaria striata* and velvet beans. The cultures with dry *Crotalaria striata* and velvet beans incorporated 10 to 15 inches deep in the soil grew seedlings showing a lower nitrogen recovery than other methods of handling these materials.

4. In the lysimeters with rough lemon seedlings there were no consistent variations in quantities of water leached which could be correlated with methods of incorporation of the *Crotalaria striata* and velvet beans with the soil. In the cultures without rough lemon seedlings the use of *Crotalaria striata* and velvet beans as mulches materially increased the quantities of water leached through the lysimeters. Incorporation of green materials with the surface soil and deep incorporation of dry materials increased the amount of water percolating through the lysimeters above that obtained without the addition of these materials, but not nearly to the extent of their use as mulches, while the incorporation of dry materials with the surface soil had very little effect on the quantities of water leached.

5. The use of *Crotalaria striata* and velvet beans as mulches and the incorporation of the dry materials with the surface soil retarded the rate of leaching of nitrate nitrogen in the early stages of decomposition.

6. The content of the well decomposed portion of soil organic matter was increased slightly for the 0 to 9 and 9 to 18 inch depths by additions at the rate of approximately 23 tons of dry *Crotalaria striata* and 21 tons of dry velvet beans.

7. The residues of the *Crotalaria striata* and velvet bean mulches showed that after 20 months, 78 percent of the crotalaria and 74 percent of the velvet beans were decomposed, resulting in a transfer of 84 percent and 78 percent of the nitrogen of crotalaria and velvet beans, respectively, to more soluble forms.

In the more extensive second series of cultures the lysimeters were filled with Norfolk fine sand on October 23 and the tanks were allowed to stand untreated and exposed to the leaching rains until February 27 of the following year, when 10 of the tanks were planted to rough lemon seedlings of uniform size. All the cultures were fertilized with commercial nitrate of soda, diammonium phosphate and potassium sulfate. On February 9 of the year following the setting of seedlings the experiment with *Crotalaria striata* and Natal grass was started. Thus the rough lemon seedlings were well established in the cultures before the cover crop materials were added to them.

The cover crop materials were air-dried and cut into approximately 4-inch lengths for use in the cultures. The dried cover crop materials were used at the rate of 2 pounds per culture for the *Crotalaria striata* and 1 pound for Natal grass. Cultures were maintained without the addition of cover crop materials and with the use of cover crop materials as a mulch and incorporated with the surface soil. Duplicate cultures in a series with and without rough lemon seedlings were established for each method of handling the summer cover crop materials. The cultures with *Crotalaria striata* received 10 grams of superphosphate and 2 grams of potassium sulfate; the Natal grass cultures and those without additions of summer cover crops received 5 grams of commercial nitrate of soda in addition to the superphosphate and potassium sulfate.

Additional applications of 2.5 grams of commercial nitrate of soda were made on April 2 and June 8, the second year after the seedlings were set. The experiment was discontinued on August 31 of that year, after a period of 568 days, and after proper collection of samples of the rough lemon seedlings, the cover crop residues, the water and the soil had been made. Chemical analyses of these samples were made, using standard procedures.

The result of this experiment may be summarized as follows:

1. The largest rough lemon seedlings were produced by the incorporation of *Crotalaria striata* with the surface soil; the second largest by the use of this summer cover crop as a mulching material. The heavy application of Natal grass both incorporated with the surface soil and used as a mulch produced smaller seedlings than were produced in cultures without the addition of cover crop materials. The detrimental influence of the mature non-leguminous Natal grass on the rough lemon seedlings may be attributed to the competition of the soil microorganisms for nitrogen in the early stages of decomposition of this material.

2. The leaves, stems and roots of the rough lemon seedlings grown with the decomposing cover crops had a higher percentage of nitrogen than those grown without cover crop material. The higher percentages in the plants grown with *Crotalaria striata* may be attributed to the greater supply of nitrogen added in the cover crop material, while the higher percentages in the seedlings grown with Natal grass may be attributed to the increased availability of nitrogen during the late stages of decomposition of this cover crop material.

3. Variations in percentages of phosphorus in the leaves and stems of the rough lemon seedlings grown under the different conditions were not sufficiently large to have any great significance. Percentages of phosphorus in the roots were highest in seedlings grown with Natal grass, lowest in plants grown with crotalaria, and intermediate in plants grown in Norfolk fine sand without cover crop additions.

4. Leaves, stems and roots of seedlings grown with Natal grass had much higher percentages of potassium than those grown with *Crotalaria striata* or without the addition of cover crop materials.

5. Highest percentages of calcium were found in seedlings without cover crop additions, with the exception of roots of plants grown with the Natal grass mulch. Percentages of calcium in leaves and stems of plants grown with *Crotalaria striata* were substantially higher than those grown with Natal grass.

6. Partial chemical analyses of samples of *Crotalaria striata* and Natal grass and of the residues of these cover crop materials after decomposing for 596 days in the surface soil or as a mulch were made. Eighty-seven percent of the organic matter of crotalaria decomposed when it was incorporated with the

soil; 72.0 percent when used as a mulch. With Natal grass, 95.9 percent of the organic matter was decomposed when it was incorporated with the soil, and 63.0 percent when used as a mulch. Similar results were obtained for the loss of nitrogen and carbon from these cover crop materials. The carbon-nitrogen ratio of the *Crotalaria striata* was 31.03; this ratio decreased to an average of 22.76 in the residues. For the Natal grass this ratio was 52.87 in the undecomposed material and 22.81 for the residues.

7. The calcium, phosphorus and potassium contents of the *Crotalaria striata* and Natal grass and their residues were determined. The calcium content of crotalaria increased from 0.759 percent in the undecomposed material to 1.499 percent in the incorporated residue and 1.331 percent in the mulch residue. The calcium content of Natal grass increased from 0.339 percent in the undecomposed material to 1.657 percent in the mulch residue. The phosphorus content of the crotalaria decreased from 0.489 percent in the undecomposed material to 0.254 percent in the incorporated residue and 0.200 percent in the mulch residue. On the other hand, the percentage of phosphorus in the Natal grass increased from 0.212 percent in the undecomposed material to 0.444 percent in the mulch residue. The potassium content of the crotalaria decreased from 0.297 percent in the undecomposed material to 0.093 percent in the incorporated residue, and 0.098 percent in the mulch residue; while the Natal grass showed a decrease from 0.728 percent in the undecomposed material to 0.112 percent in the mulch residue.

However, due to the active decomposition of the cover crops both incorporated with the surface soil and used as a mulch, there was a high percentage of the calcium (except for the Natal grass mulch cultures), phosphorus and potassium liberated from the decomposing cover crops. During the period of decomposition, 75 percent of the calcium was released from the incorporated crotalaria and 51 percent from the crotalaria mulch. The residue of the Natal grass used as a mulch showed a gain in total calcium indirectly associated with an increased retention of calcium from the soil and fertilizers by the partly decomposed grass.

Of phosphorus, 93 percent was released from the incorporated crotalaria and 89 percent from the mulch of crotalaria and 47 percent from the mulch of Natal grass.

8. Both incorporation and use as mulch of large quantities of *Crotalaria striata* and Natal grass materially increased the quantities of water leached through the lysimeters without rough lemon seedlings. With seedlings the use of the large quantities of the mature non-leguminous Natal grass materially reduced growth of the seedlings, resulting in the leaching of larger quantities of water in these cultures than in the lysimeters without cover crop additions.

9. Average concentrations of nitrogen in the drainage waters of the lysimeters without seedlings were 27.6 p.p.m. for the cultures without additions of cover crop materials; 34.6 p.p.m. for those with *Crotalaria striata;* and 18.2 p.p.m. for those with Natal grass. Concentrations in the drainage water from the cultures with seedlings were 7.5 p.p.m., 3.5 p.p.m. and 6.2 p.p.m. for the corresponding cultures.

Average concentrations of potassium in the drainage waters of the lysimeters without seedlings were 6.4 p.p.m. for the cultures without the addition of cover crop materials; 12.6 p.p.m. for those with *Crotalaria striata;* and 13.3 p.p.m. for those with Natal grass. The corresponding values for the cultures with seedlings were 0.6 p.p.m., 1.2 p.p.m. and 1.3 p.p.m., respectively.

Average concentrations of calcium in the drainage waters of the lysimeters without seedlings were 40.4 p.p.m. for the cultures without the addition of cover crop materials; 48.3 p.p.m. for those with *Crotalaria striata;* and 28.4 p.p.m. for those with Natal grass. The values for the corresponding cultures with seedlings were 25.0 p.p.m., 27.9 p.p.m. and 22.8 p.p.m., respectively.

Differences in the concentrations of these elements in the leachings from cultures without seedlings and those with seedlings indicate a definite absorption of the respective elements by the seedlings.

10. Average monthly concentrations of potassium in the drainage waters from the lysimeters with and without seedlings show an absorption of potassium by rough lemon seedlings during all seasons of the year. The liberation of potassium from the decomposing cover crop materials maintained the concentration of potassium in the drainage waters at a substantially higher level than from the soil without additions of plant materials.

11. A study of the distribution of the nitrogen added as fertilizer and cover crop materials to the cultures shows substantially larger amounts of nitrogen leached from the cultures with-

out rough lemon seedlings. Larger quantities of nitrogen were recovered by the larger seedlings grown in the crotalaria cultures. The seedlings grown in the cultures without cover crop additions recovered more nitrogen than was obtained by seedlings grown in the cultures receiving large additions of mature Natal grass. Residues of the cover crop materials used as mulches contained very much larger quantities of nitrogen than those of the incorporated materials. The largest gain of nitrogen in the soil was in the cultures where *Crotalaria striata* was incorporated with the surface soil. Other treatments failed to show significant gains in soil nitrogen.

12. Additions of phosphorus to the cultures were highest for the soils with *Crotalaria striata* incorporated with the surface soil or used as a mulch and lowest in cultures without cover crop additions. Largest quantities of phosphorus were recovered in the seedlings grown with crotalaria and the smallest in seedlings grown with Natal grass. The seedlings in the cultures with fertilizers alone were intermediate in phosphorus recovery. Very small quantities of phosphorus were recovered in the cover crop residues.

13. Largest quantities of potassium were applied to cultures having applications of mature Natal grass. Very small quantities of potassium remained in the cover crop residues. Substantially larger quantities of potassium were leached from the cultures without rough lemon seedlings. The recovery of potassium in the seedlings was materially greater for those grown in the presence of cover crop materials.

14. The quantity of calcium added in the *Crotalaria striata* was several times larger than the total added in Natal grass and in the fertilizers. Less calcium was leached from the cultures with seedlings than from those without seedlings. By far the largest quantity of calcium was recovered in the rough lemon seedlings grown with the crotalaria incorporated with the surface soil and the second largest with the seedlings grown without cover crop additions. Total calcium content of the seedlings grown with mulched crotalaria was nearly as great as that without additions of cover crop materials. The content of this element in the seedlings grown with Natal grass was approximately half that of the other seedlings. Approximately half of the calcium contained in the *Crotalaria striata* was found in the mulch residue; approximately one-quarter in the residue of the crotalaria incorporated with the surface soil.

Bulletin 342 December, 1939

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UNIVERSITY OF FLORIDA
AGRICULTURAL EXPERIMENT STATION
GAINESVILLE, FLORIDA
WILMON NEWELL, Director

CONTROLLING TOBACCO DOWNY MILDEW (BLUE MOLD) WITH PARADICHLOROBENZENE

By W. B. TISDALE and RANDALL R. KINCAID

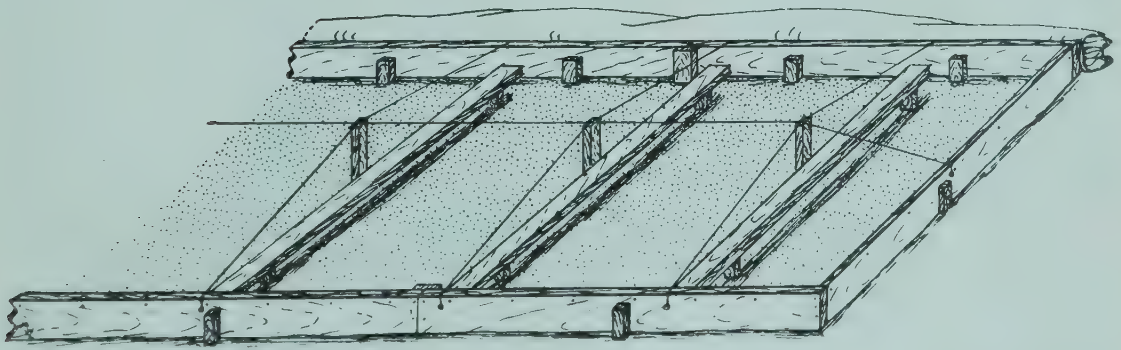

Fig. 1.—Diagram showing construction of tobacco plant bed, using boards for vaporizing PDB, and gathering the sheeting cover to one side of the bed.

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CONTROLLING TOBACCO DOWNY MILDEW (BLUE MOLD) WITH PARADICHLOROBENZENE

By W. B. TISDALE and RANDALL R. KINCAID

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INTRODUCTION

Paradichlorobenzene for controlling tobacco downy mildew was reported to have been used successfully in 1938 in South Carolina, but further information was needed concerning the best methods of applying the treatment under Florida conditions. Therefore, in 1939, experiments were set up in early February in plant beds where downy mildew appeared at that time. Other experiments were conducted in March when the general outbreak of downy mildew occurred. From these experiments considerable information was obtained concerning the amount of paradichlorobenzene necessary to use in different weather conditions, and on the methods for applying it. Farmers who saw the experiments became very enthusiastic over the effectiveness and simplicity of the treatment, and as a result more than 6,000 pounds of paradichlorobenzene were used in two counties where sales records were obtained.

The purpose of this bulletin is to report the most effective methods developed for applying the paradichlorobenzene treatment and to give some of the results obtained.

PARADICHLOROBENZENE TREATMENT

The paradichlorobenzene treatment is a new method for combating plant diseases. Paradichlorobenzene may be purchased under various trade names, such as "Paracide" and "Para-Baco", and is commonly called PDB. For brevity, it will be called PDB in this bulletin. PDB may be obtained in the form of white crystals of various sizes, ranging from that of coarse ice cream salt to table salt. Intermediate sizes, which average about the size of rice grains or slightly smaller, are the most desirable to use for controlling tobacco downy mildew. The largest sizes vaporize too slowly and the smallest sizes are difficult to distribute evenly. About 75 percent of the "rice" crystals will be retained on a 10-mesh screen, whereas about 95 percent of the smaller size will pass through a 10-mesh screen and about 78 percent of them will be retained on a 20-mesh screen. When the crystals are exposed to the air they form a vapor or gas that is heavier than air. Neither the solid nor the gas is inflammable.

LOCATION OF BEDS

Tobacco plant beds should be located on new land as far as practicable from the previous year's beds to avoid infection while the plants are small. They should be prepared for the treatment before sowing. The land should be cleared of all stumps, which would interfere with the treatment and would occupy valuable space. The land should be well drained, but not too steep, preferably with a slope of not more than 5 feet in 100. Beds should be protected from sweeping winds, if possible, but should have a maximum of sunlight, preferably with an eastern exposure. Beds running north and south are slightly better than those running east and west, because fewer plants are shaded by the frames. A space of 1 or 2 feet should be left between the beds to serve as a walkway.

SIZE OF BEDS

If the PDB treatment is used it is not necessary to plant the excess yardage of bed that has been commonly used during the last 6 years. The necessary plant bed area is 100 square yards for 3 or 4 acres of flue-cured or for about 1 or 2 acres of shade-grown cigar-wrapper tobacco.

Beds to be treated with PDB should be approximately 6 or 9 feet wide (not over 12 feet), and preferably not over 75 feet long. The heavy cloth covers required for this treatment are usually made by sewing together strips of cloth 1 yard wide. The actual width of the beds should be at least 6 inches less than the width of the cover so that the cloth can be drawn down over the top edges and fastened on the sides rather than on top of the frames. If the cloth is fastened to the top edges of the frames it sags between the nails and leaves openings through which the vapor escapes. Narrow beds are easier to treat than wide beds, and they can be treated and weeded without walking over them, thus saving many plants. Also, heavy cloth covers wider than 12 feet are very difficult to handle, especially when wet, without injuring plants and brushing off the PDB from the boards.

All beds in a given location should be of the same size so that the heavy cloth covers may be used interchangeably on them as needed. Thus, if only about 100 square yards of plant area are required, this may be divided into two beds of equal size and enough heavy cloth bought for only one to effect a saving in the cost of cloth. In 1939 many farmers bought only one-half as many yards of cloth as the plant bed area and successfully treated the entire area by first treating one portion of the bed and then shifting the treatment to another. This can be done if treatment is started as soon as first signs of the disease appear.

CONSTRUCTION OF FRAMES

Plant beds should be tightly framed before the seeds are sowed. The frames are constructed preferably of boards from 10 to 12 inches wide and free of holes and cracks. Logs may be used if they are fitted to make the top edge of the frame smooth and straight. The frames should be banked around the outside with soil to fill any low places.

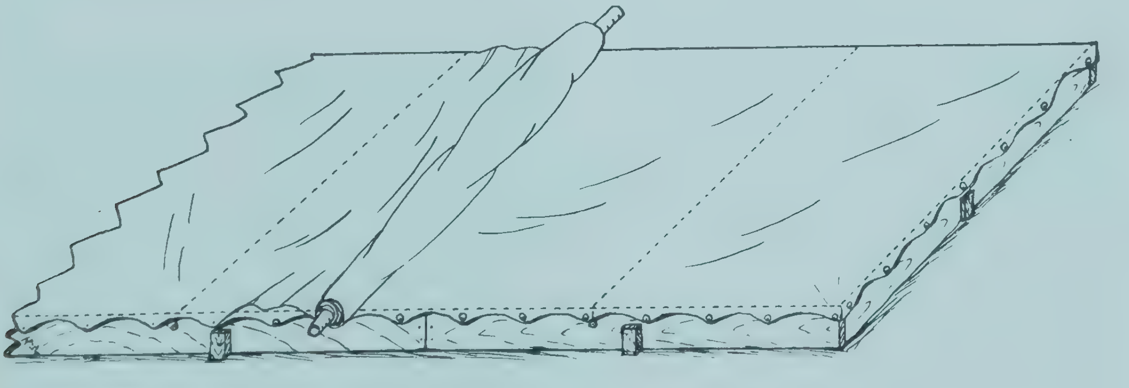


Fig. 2.—Diagram showing construction of tobacco plant bed, using ordinary plant bed cloth for vaporizing PDB, and rolling the sheeting cover to one end of the bed.

If boards are used for vaporizing the PDB a wire should be stretched lengthwise over the center of the bed and supported about 3 inches higher than the frame by small posts placed every few feet. Poles may be used instead of this wire. Other wires stretched crosswise over the bed should be used to support the cloth at least 6 or 8 inches above the plants. These crosswise wires should be supported in such way as to keep the cloth from sagging and brushing the crystals off the boards while it is being placed over the bed, and also to keep water from running through the cloth directly over the boards and washing off the crystals. The construction of this type of bed is shown in Figure 1.

If the ordinary plant bed cloth is used for vaporizing the PDB the center wire may be omitted or placed on a level with the side walls so that the cloth will be in a horizontal position (Fig. 2).

BOARDS FOR VAPORIZING PDB

To promote adequate vaporization of PDB and to obtain an even distribution of the vapor in the beds it is necessary to distribute the crystals on a suitable support above the plants. Boards have been found satisfactory for this purpose. Rough boards, 5 or 6 inches wide, running the length or width of the bed, are placed above the plants. The PDB crystals slide off of dressed boards very easily. Six-inch boards are better than narrower ones because this width gives a greater surface for spreading the PDB; wider ones shade too many plants and may interfere with the treatment, as shown by the fact that in one instance downy mildew was not killed under 12-inch boards. The boards should be at least 3 or 4 inches above the tops of the plants and so placed in the beds that all plants are within 3 feet of the crystals.

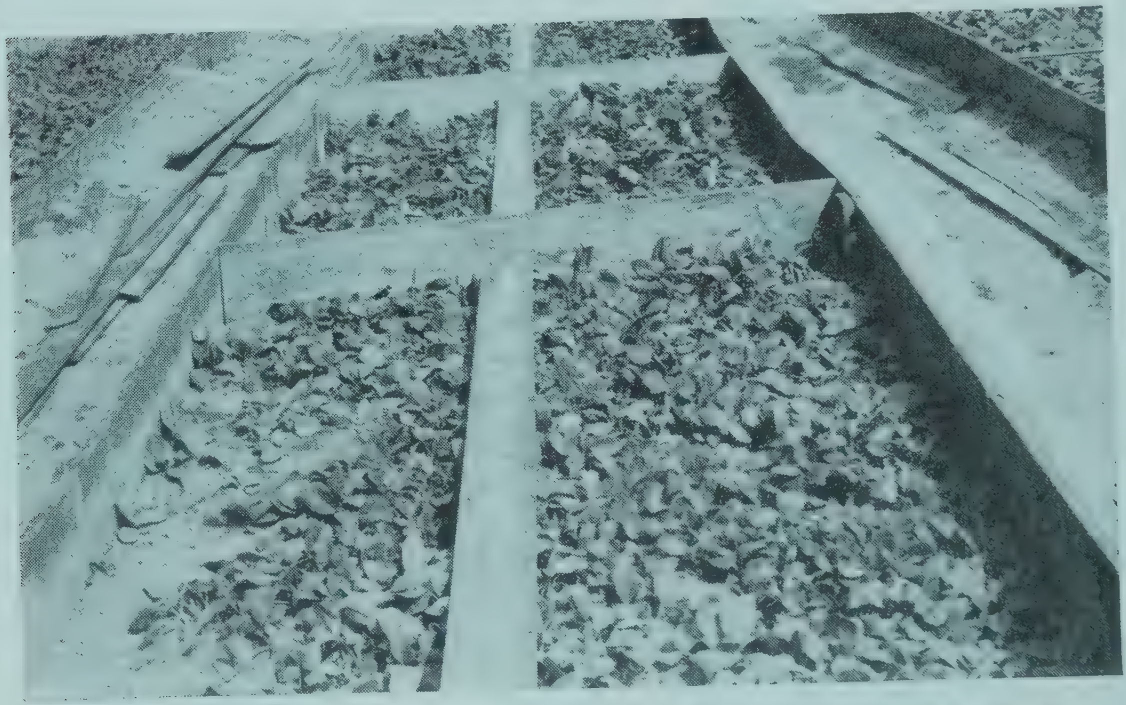


Fig. 3.—Experimental plant bed showing method of applying PDB in a 6-foot bed. (Photo by Agronomy Department.)

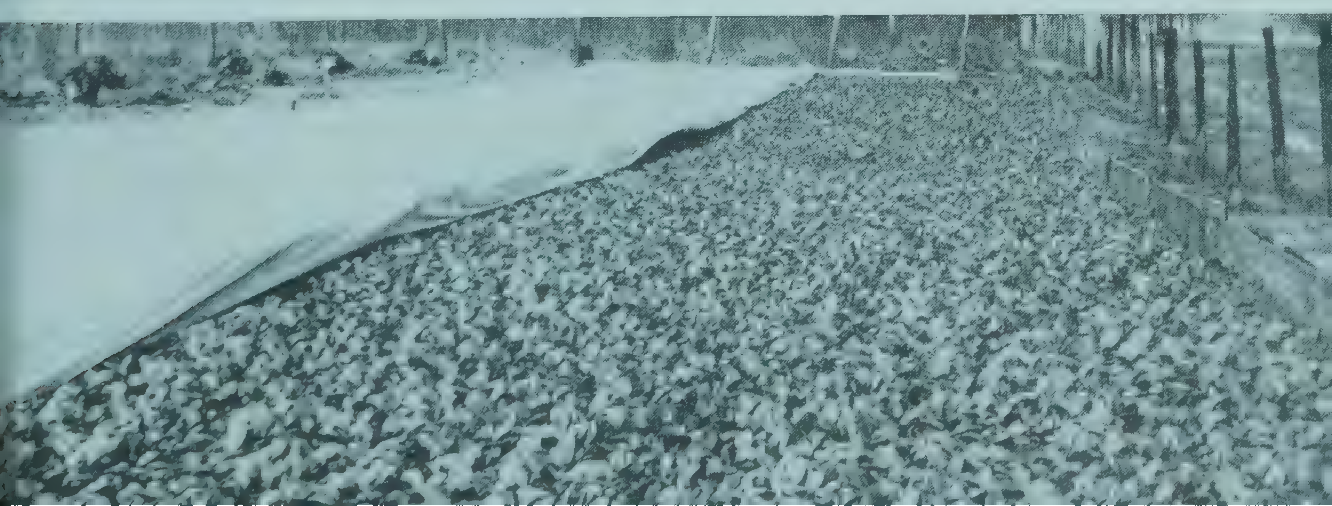
In a bed 6 feet wide one board placed lengthwise in the center gives adequate vaporizing surface (Fig. 3). In a bed 9 or 12 feet wide two boards may be placed lengthwise of the bed and about 2 or 2½ feet from the side walls, or crosswise every 6 feet, beginning 3 feet from the ends (Fig. 1).

Bricks, wooden blocks, or shingles driven in the ground may be used as supports for the boards, but probably it would be more convenient to nail legs of the proper length and width on the boards, as shown in Figure 1. The PDB can be distributed on the board outside the beds and then be placed in position. These boards should be removed from the beds when the treatment is completed to prevent shading the plants.

CLOTH FOR VAPORIZING PDB

Instead of using boards to vaporize the PDB, this material may be distributed on the regular plant bed cloth left stretched over the beds. The heavy sheeting necessary to retain the vapor is then placed over this and fastened to the frames. When this method is used the cloth should be supported in a horizontal position over the beds as shown in Figure 2. This method of distribution was used in several instances in 1939 and gave complete control of downy mildew wherever used. Figure 4 shows the first bed in which the PDB was distributed on the regular plant bed cover. The regular plant bed covers used in these instances were new and of a heavy grade with 24 to 28 threads per inch. To be satisfactory for this purpose the cloth should be free of holes and of mesh fine enough to keep the PDB crystals from falling through on the tobacco plants. This appears to be the most economical and effective method for distributing and vaporizing PDB.

Fig. 4.—Plant bed in which downy mildew was controlled by distributing the PDB on the regula plant bed cover. The bed cover and sheeting are removed from half of the bed to show condition plants at end of treatment.



SHEETING COVERS

A cover tight enough to retain PDB vapor effectively must be kept over the bed during the time when the treatment is being applied. Such a cover is made of unbleached sheeting, woven with about 52 to 60 threads per inch each way, and weighing about 4 ounces per square yard. This grade of cloth was purchased in 1-yard widths in the North Florida counties in 1939, and sewed together on the farms to make the desired width of cover. Wider cloth costs more per square yard, cloth of coarser weave does not retain the vapor effectively, and heavier sheeting is difficult to handle. The cloth generally used for flue-cured tobacco bed covers or tobacco shade cloth is not effective, even when doubled several times. Tarpaulins are too heavy for handling conveniently and may cause injury to the plants in warm weather.

The cloth may be fastened to the frame with small nails driven through the edges, but this often tears the cloth. The life of the cloth can be increased by inserting small metal eyelets or grommets about every 18 inches along the edge of the cloth. These eyelets are slipped over nails driven in the outside walls of the frames at the proper distances to insure a close fit of the cloth on the top edge of the frame, making the operation much more convenient than when nails are driven through the cloth.

A wet cloth retains the vapor much better than a dry one, and for this reason the cloth should be thoroughly wetted after it is placed over the bed. It may be wetted with a hose, sprinkled with a sprinkling can or a broom, or sprayed with a spray pump. Water should not be dashed on with a bucket because of the danger of washing off the crystals from the boards. Since new cloth is not readily wetted uniformly, it is advisable to wash new cloth before using it.

WHEN TO USE PDB

The PDB treatment can be applied during rainy weather when it is likely to be needed most.

The treatment should be started when first signs of downy mildew are found in the plant bed. However, the beds should be properly arranged and framed, and the inside boards, sheeting covers and PDB should be ready in advance. Plants are grown under the regular plant bed covers until time to start the treatment. When the disease is reported in the community, a careful daily inspection of the beds should be made to discover its presence as soon as possible.

There seems to be little advantage in applying PDB before the disease appears in the plant beds. Smaller quantities or less frequent applications of PDB than those required to check the disease will not keep it out of the beds, especially when used under the regular plant bed cover. Furthermore, the plants are susceptible to infection again as soon as the treatment is discontinued, provided weather conditions are favorable for the disease. Therefore, if the treatment be used as a preventive it would probably be necessary to keep PDB on the bed continuously during the period when downy mildew threatens. For these reasons it seems more economical to delay treatment until downy mildew is found in the bed and then use enough PDB to kill it.

The disease may reappear within a week or 10 days after the treatment is completed, and if it does the treatment should be repeated. In 1939 the disease reappeared in all except one of the beds treated in February. On the other hand, it reappeared in only a few of the numerous beds treated in March after which weather conditions were unfavorable for the disease. Thus, when the disease does not appear until late in the season it is probable that only one treatment will be required in most cases.

If the treatment is started in time half of the plant bed area can be treated and then the covers and also the inside boards, if these are used instead of the regular plant bed cloth for vaporizing the PDB, can be moved to the other half of the plant bed area and used as before. This effects a considerable saving in the cost of sheeting and of lumber. Many farmers used this system in 1939 with satisfactory results.

AMOUNT OF PDB REQUIRED

The amount of PDB which must be actually vaporized to control downy mildew is about 1 to 1½ pounds per 100 square yards of plant bed per night. The amount that must be applied to give this required concentration of vapor depends on the temperature, moisture and size of crystals. It also depends upon the area and nature of the surface over which the crystals are scattered, as discussed above.

Temperature has a large effect on the rate of vaporization of PDB. In average weather during the plant bed season an application of from 2 to 4 pounds per night is sufficient, the largest amount being used during cold weather. However, at freezing temperatures and below there is practically no vaporization of PDB and nothing is to be gained by applying it. Fortunately, downy mildew seems to be inactive at these temperatures, although it is not killed.

Coarse crystals evaporate more slowly than fine crystals. If fine crystals are placed in piles they form a cake or crust which slows down the rate of vaporization. This tendency to cake or crust, however, can be eliminated by thoroughly mixing with the PDB crystals 1 percent or less of fuller's earth, kaolin, powdered charcoal, limestone, hydrated lime or very fine dry soil, thereby providing a more uniform rate of vaporization.

Laboratory tests showed that wetting the crystals reduced the rate of vaporization slightly. The disease was checked in the plant bed, however, when it was cloudy and raining from one to several times a day and the temperature dropped below 40° F. at night. The treatment appears to be as effective when the plants are wet as when they are dry.

Because of these factors affecting the rate of vaporization of PDB, the dosage which must be applied to vaporize the amount actually required varies considerably under different conditions. Unless the crystals left on the board are weighed, the amount vaporized cannot be determined very accurately. However, the grower can judge whether he is using the right amount of PDB. If too little is used the disease will not be checked by the treatment and if too much is used the plants may wilt slightly for a day or two after the treatment is discontinued in warm weather.

HOW TO USE PDB

Downy mildew has been successfully checked by treating with PDB (1) for three successive nights, removing the cloth during the day, and (2) for 48 hours, leaving the cloth over the bed night and day.

1. **The 3-Night Treatment.** This treatment should be used when the days are clear and warm. The amount of PDB applied per night varies from 2 to 4 pounds per 100 square yards, in order to vaporize 1 to 1½ pounds actually required to control the disease. During average spring weather when night temperatures range between 40° and 55° F., from 2 to 3 pounds should be used; on cool nights when the temperature drops to 40° F. or below, 4 pounds should be used. The required amount

of PDB is applied at about 5 or 6 o'clock in the afternoon and the cover is immediately spread over the bed, fastened to the frame, and sprinkled or sprayed with water. The cover is removed about 8 or 9 o'clock in the morning. If boards are used for vaporizing, the PDB left may be brushed off and saved for future use. This treatment, continued for three successive nights, gave perfect control in several beds in February (Fig. 5). Under some conditions a 2-night treatment may be sufficient, but it has not proved to be in all instances.

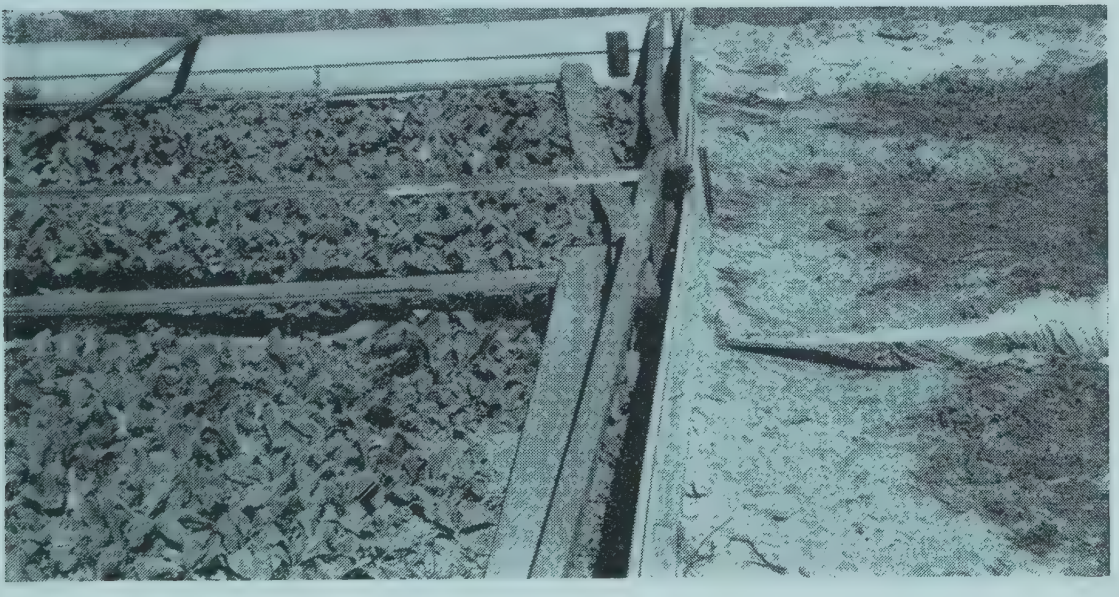


Fig. 5.—Experimental plant bed in which downy mildew was controlled in February by using PDB for three successive nights. All plants in non-treated portion (right) of bed were killed by the disease. The bed was retreated on March 3, 4 and 5, and photographed March 13, 1939.

2. **The 48-Hour Treatment.** This treatment may be used when the days are cold, or cool and cloudy. From 3 to 4 pounds of PDB per 100 square yards are applied at about 5 or 6 o'clock in the afternoon, and the cover is immediately spread over the bed, fastened to the frame, and sprinkled, provided it is not already wet. The same amount of PDB is applied again the next afternoon and the cloth is wetted again. It may be advisable to wet the cloth also during the day if the weather is dry and windy. Dividing the total amount of PDB between two applications reduces the danger of injuring the plants if the weather becomes fair and warmer during the day, and also gives the plants some fresh air while the second dose is being applied. This treatment proved completely effective under conditions where it was tested (Fig. 6).

The 48-hour treatment involves less labor than the 3-night treatment. Since it is also completed in less time, the 48-hour treatment seems to be more practical whenever the weather is favorable for its use.

Plants should be examined carefully after the completion of either treatment. If the mildew on the leaves is bluish or light gray in color, indicating that the disease is still active, the treatment should be continued for another night or 24 hours.

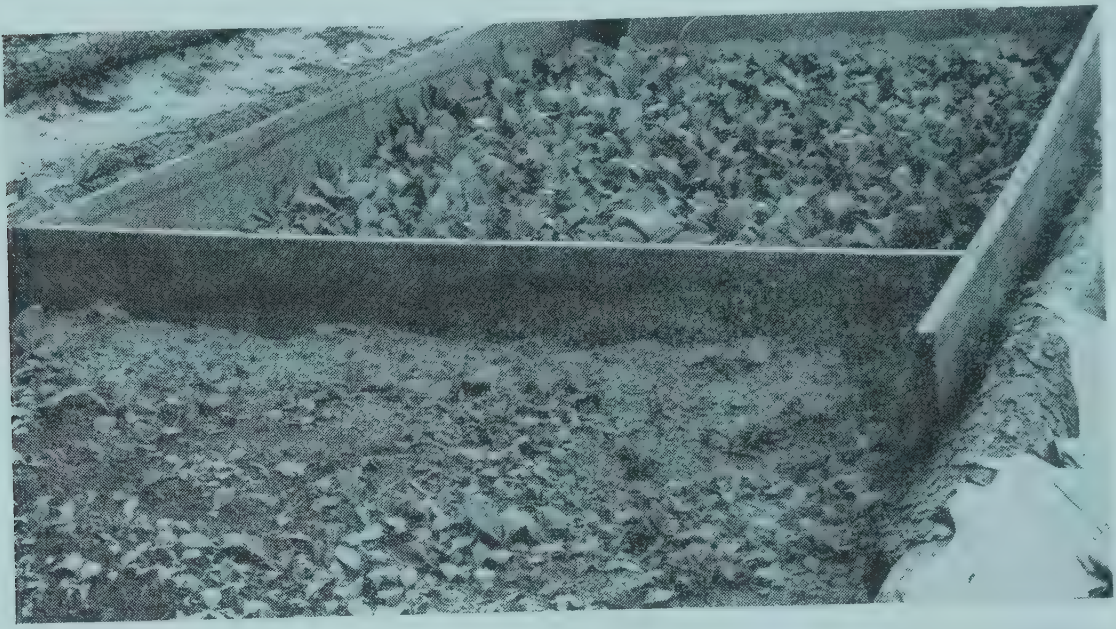


Fig. 6.—Experimental plant bed in which downy mildew was controlled with PDB in a 48-hour treatment. Photographed March 16, when plants in treated portion of bed were ready to transplant.

Since the vapor of PDB is heavier than air it does not spread very far in the bed when there are no air currents. Therefore, it is important to scatter the crystals as evenly and uniformly as possible on the boards (Fig. 3) or cloth in all parts of the bed. Thoroughness with which this is done can be determined by the amounts and location of crystals left on the boards in the morning after it was applied the afternoon before.

No permanent injury was observed from the use of these methods under a wide range of weather conditions. In a few cases where tarpaulins or other heavy materials were used for covers and the frames were low, leaving very little space between the cover and plants, considerable injury developed. Large plants, especially when the stand was thick, wilted badly when the cloth was left over the beds during warm, bright days, but they revived after the cloth was removed and showed no signs of injury after a few days. Many farmers transplanted the plants to the field on the second or third day after completing the treatment and reported that a high percentage of them lived.

REMOVING COVERS FROM BEDS

The heavy cloth should be removed from the beds as soon as the treatment is completed. To remove the cloth it is unfastened on the ends and one side and rolled or gathered up along the frame on the other side (Fig. 1). Another method which is perhaps more convenient is to unfasten the cloth on both sides and one end and roll it lengthwise of the bed on a pole or a narrow board (Fig. 2).

In warm weather the beds may be left uncovered between periods of treatment to harden the plants and to make conditions less favorable for downy mildew. If there is danger of frost the regular plant bed cover should be replaced over the beds. The sheeting covers have also been found to give excellent protection to the plants in freezing weather.

COST OF TREATMENT

Cost of the PDB treatment will vary somewhat with the width of beds, kind of materials used for frames, difference in price of sheeting in various localities, and the choice of boards or the regular plant covers for distributing and vaporizing the PDB.

A given yardage of plant bed can be framed with a smaller amount of lumber if the bed is made 3 or 4 yards wide than if it is made 2 yards wide. For example, 100 square yards in a bed 4 yards wide (25 yards long) would require 174 lineal feet of boards; 3 yards wide (33⅓ yards long), 218 lineal feet; 2 yards wide (50 yards long), 312 lineal feet.

Approximately 150 lineal feet of boards will be required for distributing and vaporizing the PDB per 100 square yards of bed under treatment at one time, except for a bed 3 yards wide with two boards placed lengthwise, in which case 200 lineal feet would be required. These boards can be used interchangeably in two areas.

The price of sheeting will vary from year to year and may vary in different localities in any year. It was purchased in 1-yard widths in 1939 at 7 to 8 cents per yard. By treating only half of the plant bed area at one time it is necessary to purchase only about one-half as many yards of the sheeting as the yardage of plant bed. With proper care, the cloth should last for several years, although this time has not been determined by actual experience.

The price of PDB in 1939 ranged from about 15 cents per pound in 100-pound drums to 25 cents per pound in 4-pound cans. With general use for controlling downy mildew it may become cheaper. At the above prices the cost of 6 to 8 pounds of PDB necessary for a complete treatment of 100 square yards will vary from a minimum of 90 cents (6 pounds at 15 cents) to a maximum of $2 (8 pounds at 25 cents).

Since the heavy cloth and PDB are necessary for the control of downy mildew, the cost of these two items must be incurred. For the first year the maximum cost of these items per 100 square yards of bed, figuring $4 for 50 square yards of cloth and $2 for PDB for one 3-night or 48-hour treatment, would not exceed $6 if only one treatment is necessary, or $8 if two treatments are necessary. For the second and succeeding years, as long as the original cloth could be used, the maximum cost of PDB only would be $2 for one treatment or $4 for two treatments.

If suitable log frames are used and the PDB is vaporized from the regular plant bed cover, the cost of boards for these purposes can be eliminated. However, it is considered more desirable to use boards for the frames.

The saving effected by reducing the yardage of plant bed to a minimum may largely offset the cost of the PDB treatment.

PRESERVING THE CLOTH

The sheeting should last for several years if it is properly treated, thoroughly dried, and stored where rats will not destroy it. The life of the cloth can be greatly increased at nominal cost by soaking it in a solution made up as follows: 4 pounds zinc sulfate, 4 pounds sal soda, 1 pound tartaric acid and 150 gallons water. The solution is made by dissolving the zinc sulfate and sal soda separately in one-half the total volume of water. These two solutions are stirred together and then the tartaric acid dissolved in a little water is added while stirring. This quantity is sufficient to treat about 1,000 yards of cloth. Larger or smaller volumes of the solution may be made, using the same proportions.

The cloth is soaked in the solution for 48 hours and then hung up without wringing and allowed to dry thoroughly before storing.

SUMMARY

The paradichlorobenzene (PDB) vapor treatment has proved highly effective in controlling downy mildew of tobacco. This method is simple and comparatively inexpensive. It can be successfully used during rainy weather when treatment is needed most.

Narrow beds, approximately 6 or 9 feet wide, are most convenient and probably most economical to treat.

If the PDB treatment is used it is necessary to plant only the regular yardage of plant bed area; that is, 100 square yards for 3 or 4 acres of flue-cured tobacco, or for 1 to 2 acres of shade.

It is necessary to purchase only one-half as many yards of the sheeting as there are yards in the plant bed. When the disease is checked on one bed or part of a bed treatment is shifted to another.

The frames must be made tight and high enough so the crystals can be placed above the tops of the plants. Ten- or 12-inch boards give best results.

The crystals must be supported above the plants in such way that none of the plants will be over 3 feet away. Rough 6-inch boards placed lengthwise or crosswise of the bed have proved satisfactory for this purpose. Better distribution may be obtained by placing the PDB on the regular plant bed covers of fine enough mesh to keep the crystals from falling through; this is the most economical and probably the most effective means of vaporization.

It is not necessary to keep the PDB dry after placing it in the plant bed but if it is distributed on boards the cover should be supported in such manner that it will not sag immediately over the boards, permitting water to accumulate, stream through and wash off the crystals. Wetting retards the rate of vaporization slightly, but the treatment has been used effectively in rainy weather.

Covers made of sheeting with about 52 to 60 threads per inch each way must be fitted tightly over the beds after the PDB has been applied to prevent escape of the vapor. The cover should be sprinkled or sprayed with water after it is placed over the bed to make it more effective. This cloth and the inside boards should be removed as soon as the treatment is completed.

Treatment is started preferably when first signs of the disease are discovered. There appears to be nothing gained by starting the treatment before downy mildew appears in the bed. If the disease reappears in the bed the treatment should be repeated.

The amount of PDB which must be applied in order to vaporize the required dosage varies considerably with temperature and other factors. With the 3-night treatment from 2 to 4 pounds of PDB are applied per 100 square yards of bed per night. With the 48-hour treatment from 3 to 4 pounds of PDB are applied per 24-hour period.

For the treatment to be effective the crystals must be thinly and evenly distributed throughout the bed.

The PDB treatment has caused no injury to the plants when properly applied.

The cost of the treatment over a period of years appears to be reasonable and may be largely offset by the saving in cost of excess plant bed area. With proper care the sheeting covers should last several seasons.